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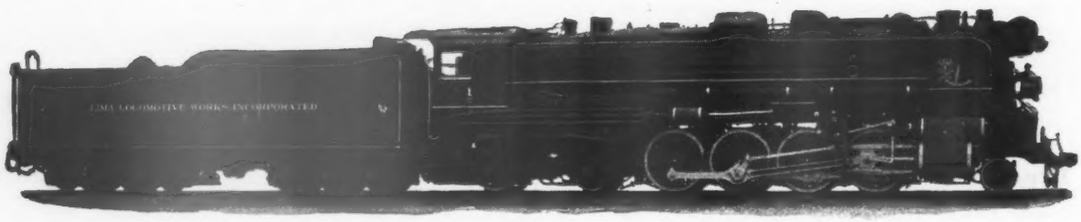
THE LIMA "A-1"

WAS THE DADDY OF THEM ALL



In the November 17th issue of the Railway Age there appeared a table showing that 298 locomotives of the 2-8-4 type had been built since 1925.

To this list should be added the LIMA "A-1" which was later sold to the Illinois Central Railroad.

"A-1" was the first of this type of locomotive ever built and it was designed and built by the Lima Locomotive Works, Incorporated at their own expense.

Since the "A-1" was brought out, the same principles of Super-Power design have been embodied in a great many types other than the 2-8-4, thus enabling the Railroads to move more traffic at greater speeds but with a reduction in fuel and maintenance expense, thereby increasing their revenue.

Super-Power Locomotives will increase your revenue.

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Railway
Mechanical Engineer

Founded in 1832 as the American Rail-Road Journal

January - 1935

General Purpose 4-8-4 Type Locomotives for D. L. & W.

Twenty more "Pocono Type" locomotives now being placed in service for either fast freight or heavy passenger runs

THE American Locomotive Company is now completing delivery of 20 locomotives of 4-8-4 type to the Delaware, Lackawanna & Western which will be used to handle either fast freight or heavy through passenger trains between Hoboken, N. J., and Buffalo, N. Y., a through run of approximately 400 miles in length. Upon completion of delivery of these locomotives the road will have a total of 55 locomotives of this general type, all of which have been built by the American Locomotive Company.

The first locomotives of this type acquired by the Lackawanna were received in 1927 and were designed for heavy passenger service. They were numbered from 1501 to 1505, had 27-in. by 32-in. cylinders, 77-in. drivers, carried 250 lb. steam pressure, weighed 421,000 lb., and had a rated tractive force of 64,500 lb. A description of these locomotives was given in the *Railway Mechanical Engineer*, January, 1928.

Front view of D. L. & W. 4-8-4 type locomotive

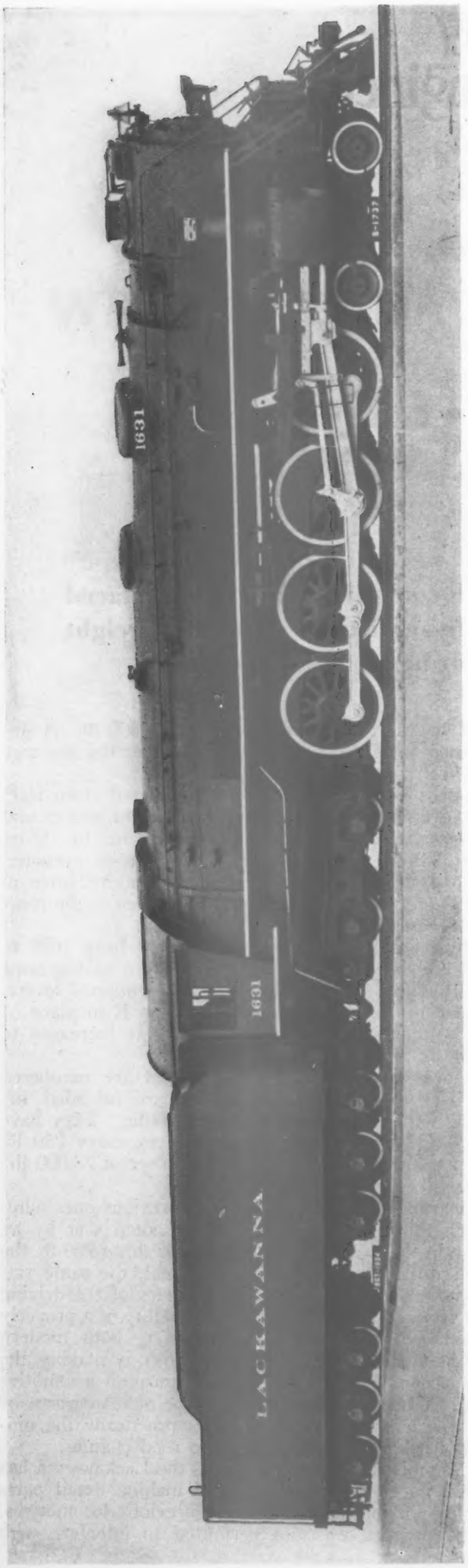
The next lot of 20 locomotives, numbered from 1601 to 1620, were designed for heavy fast-freight service and were received in 1929. They had 28-in. by 32-in. cylinder, 70-in. drivers, carried 235 lb. steam pressure, weighed 418,000 lb., and had a rated tractive force of 71,600 lb. A description of them was given in the *Railway Mechanical Engineer*, August, 1929.

A third lot, 10 locomotives, numbered from 1621 to 1630, were delivered in 1932. They were of the same general design as the previous lot, but contained several improvements in design, including Type E in place of Type A superheaters. Their weight was increased to 429,000 lb.

The present lot now being delivered are numbered from 1631 to 1650 and, as stated, are intended for handling either passenger or freight traffic. They have 28-in. by 32-in. cylinders, 74-in. drivers, carry 250 lb. steam pressure, have a rated tractive force of 72,000 lb., and weigh 447,000 lb.

Comparing these locomotives with previous ones numbered in the 1600 series, it will be noted that by an increase in the steam pressure from 235 lb. to 250 lb. the tractive force has been maintained with the same size cylinders despite the increase in diameter of the driving wheels from 70 in. to 74 in. The suitability of a properly designed 4-8-4 locomotive for handling both modern fast freight and heavy passenger trains is making the type a closer approach to a general purpose locomotive than any other type that followed the old American or 4-4-0 type which 50 years ago was practically the universally used wheel arrangement on road engines.

In designing the new locomotives the Lackawanna has followed its customary practice of making detail parts as far as possible the same as on previous locomotives, but this practice was not permitted to interfere with



Delaware, Lackawanna & Western 4-8-4 type locomotive for fast-freight and heavy passenger traffic—Built by American Locomotive Company

the inclusion of improvements when they could be made with assured advantage. Among some of the most noticeable changes in addition to size of drivers and the increase in boiler pressure are the adoption of roller bearings for all engine truck, trailer truck and driving axles; a new design of Boxpok driving wheels; inclusion as integral parts of the locomotive bed casting of the air-brake main reservoir, brackets on the front

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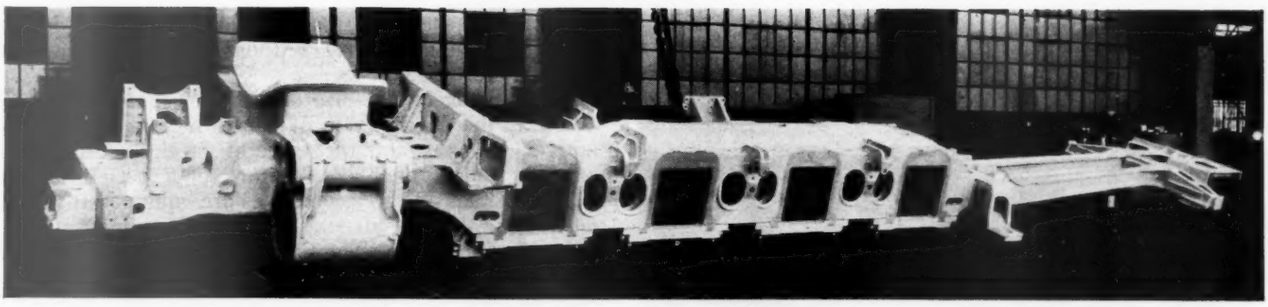
Principal Dimensions, Weights and Proportions of the D. L. & W. 4-8-4 Type Locomotives

Railroad	D. L. & W.
Builder	American Locomotive Co.
Type of locomotive	4-8-4
Road Nos.	1631—1650
Service	Freight and passenger
Cylinders, diameter and stroke	2—28 in. by 32 in.
Valve gear, type	Walschaert
Valves, piston type:	
Size	12 in.
Maximum travel	7½ in.
Outside lap	7 5/16 in.
Exhaust clearance	3/16 in.
Lead in full gear	¼ in.
Weights in working order:	
On drivers	274,000 lb.
On front truck	79,500 lb.
On trailing truck	{ 45,000 lb. F. { 48,500 lb. R.
Total engine	447,000 lb.
Tender	313,000 lb.
Wheel bases:	
Driving	19 ft. 6 in.
Rigid	19 ft. 6 in.
Total engine	41 ft. 6 in.
Total engine and tender	86 ft. 8½ in.
Wheels, diameter outside tires:	
Driving	74 in.
Front truck	33 in.
Trailing truck	{ 36 in. F. { 44 in. B.
Journals, diameter and length:	
Driving, main	12½ in.
Driving, others	11½ in.
Front truck	7½ in.
Trailing truck	7 in.
Boiler:	
Type	Conical con.
Steam pressure	250 lb.
Fuel	Soft coal
Diameter, first ring, inside	84¼ in.
Firebox, length and width	132 in. by 96¼ in.
Height mud ring to crown sheet, back	72¼ in.
Height mud ring to crown sheet, front	92 in.
Top of grate to lowest tube	26⅞ in.
Arch tubes, number and diameter	3—4 in.
Combustion chamber, length	66 1/16 in.
Tubes, number and diameter	82—2¼ in.
Flues, number and diameter	202—3½ in.
Length over tube sheets	21 ft. 6 in.
Grate type	Firebar
Grate area	88.2 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	374 sq. ft.
Arch tubes	27 sq. ft.
Syphons	95 sq. ft.
Firebox, total	496 sq. ft.
Tubes	1,033 sq. ft.
Flues	3,959 sq. ft.
Tubes and flues	4,992 sq. ft.
Total evaporative	5,488 sq. ft.
Superheating	2,180 sq. ft.
Combined evaporative and superheating	7,668 sq. ft.
Special equipment:	
Superheater	Elesco, Type E
Feedwater heater (18)	Worthington
Exhaust steam injector (2)	Elesco
Stoker	Standard BK
Tender:	
Style	Rectangular W. B.
Water capacity	16,000 gal.
Fuel capacity	26 tons
General data, estimated:	
Rated tractive force	72,000 lb.
Speed at 1,000 ft. (piston speed)	41.3 m.p.h.
Piston speed at 10 m.p.h.	242.1 ft.
Weight proportions:	
Weight on drivers ÷ total weight engine	61.3 %
Weight on drivers ÷ tractive force	3.80
Weight engine ÷ combined heating surface	58.3
Boiler proportions:	
Tractive force ÷ combined heating surface	9.4
Tractive force × diameter drivers ÷ combined heating surface	752
Combined heating surface ÷ grate area	87
Firebox heating surface ÷ grate area	5.62
Firebox heating surface, per cent of evaporative heating surface	9.04
Superheating surface, per cent of combined heating surface	28.4



Locomotive bed furnished by General Steel Castings Corporation for D. L. & W. 4-8-4 type locomotives

Special Equipment Applied on D. L. & W. 4-8-4 Type Locomotives

Builder	American Locomotive Co.
Engine numbers	1631—1650
Air brakes	Westinghouse—8ET
Air compressors	2—8½ in. cross compound
Arch, brick	American—Security
Bearings, roller, driving axles (18)	Timken
Bearings, roller, driving axles (2)	S K F
Bearings, roller, engine and trailer trucks (18)	Timken
Bearings, roller, engine and trailer trucks (2)	S K F
Bed, locomotive	General Steel Casting
Bell ringer	Transportation Devices
Blow-off cock	Wilson, 2-in.
Booster	(Not applied—provided for)
Brakes, driver	American—WN5 and BC
Brakes, tender truck (clasp)	American Steel Foundry
Brake shoes	American Brake Shoe & Fndry.
Buffer, radial	Franklin—Type D
Cab windows (clear vision)	Prime
Cab windshields	Adams & Westlake
Check valves, feedwater heater	Consolidated Ash. Hancock
Check valve, injector	Consolidated Ash. Hancock
Couplers, engine	Gould
Coupler, tender	Gould
Coupler yoke	Gould
Cylinder cocks	Ardco
Draft gear (locomotive)	Miner
Draft gear (tender)	Cardwell Westinghouse
Drawbar, engine and tender	Unit Safety
Drifting valve	Hanlon
Feedwater heater (18)	Worthington
Firedoor	Franklin—Butterfly
Flexible connections	Barco
Flue blower	Superior, Type H
Frame, tender (rectangular, W. B.)	General Steel Casting
Grates	Waugh—Firebar
Headlight, case	Pyle-National
Headlight generator	Pyle-National
Heating equipment, train	Vapor
Hinges, smokebox	O'Kadee
Horn	Westinghouse—Pneuphonic
Indicator, speed	Electric Tachometer
Injector, exhaust steam (2)	Elesco
Injector, live steam	Consolidated Ash. Hancock
Journal boxes (tender)	Symington
Journal box lids (tender)	Symington
Lagging	Johns-Manville, 85% magnesia
Low-water alarm	Barco
Lubricator, mechanical (16 feed)	Detroit Lubricating
Lubricator, air compressor	Edna
Packing, rod and valve stem	U. S. Metallic Packing—King
Plugs, arch tube	Huron
Plugs, washout	Huron
Reducing valve, steam heat	Leslie
Reverse gear	Alco, G1
Safety valves	Consolidated Ash. Hancock
Sanders	U. S. Metallic Packing
Signals, cab (3 light, audible)	Union Switch & Signal
Springs	Crucible Steel Co.
Staybolts, flexible	Alco
Staybolt iron	Ulster
Steel sheets, boiler	Bethlehem
Steel sheets, firebox crown and side	Lukens
Stoker	Standard—BK
Superheater	Elesco—Type E
Syphons, thermic	Locomotive Firebox
Tank valves	Everlasting Valve
Tank strainer	O'Kadee
Throttle valve	American—Multiple
Truck, engine (4 wheel)	General Steel Casting
Truck, trailing (4 wheel)	General Steel Casting
Truck, tender (6 wheel)	General Steel Casting
Tubes and flues	National
Valve, steam heat	Kennedy, 2-in.
Valve gear	Walschaert
Washout plugs	Huron
Water gage	Nathan
Water column	Nathan
Wheels, driving, centers	General Steel Casting—Boxpok
Wheels, engine truck	Carnegie—Rolled Steel
Wheels, trailer truck	Carnegie—Rolled Steel
Wheels, tender truck	Carnegie—Rolled Steel
Whistle	Consolidated Ash. Hancock
Whistle operator	Viloco

deck for the air compressors, and a bracket for the power reverse gear; and, the use of larger tenders. Changes have also been made in several of the air-brake details.

Clearance and weight limitations restricted the height to 15 ft. 4 in., the width to 11 ft., and the weight per driving axle to 68,500 lb.

A booster has not been applied to the trailing truck, but provision has been made in the design for its application in the future should its addition be found advisable. Of the 447,000 lb. total weight, 274,000 lb. is on the driving wheels, 79,500 lb. on the leading engine truck, and 93,500 lb. on the trailing truck—45,000 lb. on the front axle and 48,500 lb. on the rear axle. The combined length of the locomotive and tender is 90 ft. 8½ in.

The boiler, which is of conventional design, is of liberal proportions in order to provide ample generating capacity to sustain a maximum of 4,025 potential horsepower over long continued periods. The inside diameter

View of underside of D. L. & W. 16,000-gallon water-bottom tender frame

Cab of D. L. & W. locomotive showing seats for fireman and head brakeman

of the boiler at the first course is 84¼ in. The firebox is 132 in. by 96½ in. inside which gives a grate area of 88.2 sq. ft. The grates are of the Firebar type. Bituminous coal is used as fuel and is fed by a B-K Standard automatic stoker. Two Nicholson thermic syphons and three arch tubes are fitted in the firebox and one additional syphon in the combustion chamber which is 66$\frac{1}{16}$ in. long. There are 82 tubes, 2¼ in. in diameter, and 202 flues, 3½ in. in diameter, 21 ft. 6 in. long. This gives a heating surface of 496 sq. ft. in the firebox and combustion chamber and 4,992 sq. ft. in the tubes and flues, or a total of 5,488 sq. ft. evaporative heating surface.

The superheater is an Elesco Type E with 2,180 sq. ft. of surface and is expected to deliver the required amount of steam at a final temperature of between 700 and 750 deg. F. Worthington feedwater heaters are applied on the first 18 locomotives and Elesco exhaust-steam injectors on the last two locomotives. Superior flue blowers, Barco low water alarms and Franklin Butterfly firedoors are included as part of the equipment.

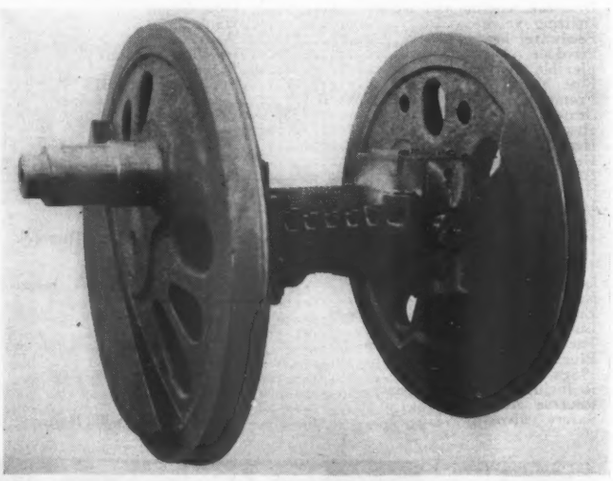
The cast-steel bed on which the locomotive is built follows current general practice and includes cylinders with integral back heads and cradle. The main air reservoir is also made a part of the bed casting for the first time on a Lackawanna locomotive. In addition to the usual brackets, including those for the air compressors at the front deck, an integral bracket has been added for the power reverse gear. The incorporation of the main reservoir and the support for the reverse gear as a part of the bed casting has made possible the elimination of a considerable number of attachment studs in the boiler shell. By care in designing the shipping weight of the locomotive bed has been kept down to approximately 68,900 lb.

The Boxpok double-disc driving wheels are of a new design, in the development of which the American Locomotive Company and the General Steel Castings Corporation collaborated. A feature of especial interest is the fact that all the locomotives are equipped throughout—engine trucks, driving axles and trailer trucks—with roller bearings. The first 18 have Timken bearings and the last two SKF bearings. The decision to use roller bearings was based on a previous experience with two engines fitted with Timken bearings which have operated satisfactorily for upwards of 225,000 miles.

The driving axles and the main crank pins are of the hollow composite type developed on the Lackawanna. A description and drawings of axles and pins of this type was given in the 1934 report of the A.R.A. Committee on Locomotive Construction. Another innovation is the introduction of a snubber spring of the coil type at the bottom of the rear trailer spring hanger. This was adopted in order to improve, if possible, the vertical riding qualities of the engine. The driving springs have reverse camber.

Valve gear of the Walschaert type operates 12-in. piston valves with 7½ in. travel. The crossheads and guides are of the multiple-ledge Laird suspended type. The throttle is of the American multiple-valve design. A Detroit mechanical lubricator with 16 feeds is provided.

The cab is large and roomy with all valves and fixtures conveniently located and marked for convenient operation. Clear-vision windows and windshields are installed. On the left-hand side there is a special seat



Main driving wheels with Boxpok double-disc centers and Timken roller bearings

Comparison of Lackawanna 4-8-4 Type Locomotives

Road Nos.	1501 to 1505	1601 to 1620	1621 to 1630	1631 to 1650
Date built	1927	1929	1932	1934
Tractive force, lb.	64,500	71,600	71,600	72,000
Weight of engine, lb.	421,000	418,000	429,000	447,000
Weight on drivers, lb.	269,000	262,000	271,000	274,000
Cylinders, in.	27 by 32	28 by 32	28 by 32	28 by 32
Drivers, diam., in.	77	70	70	74
Steam pressure, lb.	250	235	235	250
Heat. surface, firebox, total, sq. ft.	493	515	511	496
Heat. surface, tubes and flues, sq. ft.	4,700	4,621	4,934	4,992
Tube length, ft.-in.	21–6	21–6	21–6	21–6
Superheat surface, sq. ft.	1,324	1,324	2,243	2,180
Grate area, sq. ft.	88.2	88.2	88.2	88.2
Superheater	A	A	E	E
Tender, water, gal.	12,000	15,000	15,000	16,000
Tender, coal, tons	14	22	22	26

provided for the use of both the fireman and the head brakeman. As an assistance to safe and economic operation an automatic three-light cab-signal system, made by the Union Switch & Signal Company, is located within convenient range of both the engineman and the fireman. This provides both visible and audible cab-signal indications on each side of the cab.

The air-brake system is the new Westinghouse No. 8-ET form with brake valves and associated parts pedestal-mounted. Two 8½-in. cross-compound air compressors are included. Heretofore, the road has found 11-in. air compressors of sufficient capacity for their requirements.

The tender tank is mounted on a General Steel Casting Corporation water bottom underframe weighing 31,000 lb. It is of the rectangular type having a capacity for 16,000 gal. of water and 26 tons of coal, although 28 tons may be loaded by heaping. The tender is carried by six-wheel trucks of General Steel Castings design. Brake rigging is of the clasp type furnished by the American Steel Foundries. The loaded weight of the tender is 313,000 lb.

In appearance these locomotives have an unusually clean and smooth appearance both above and below the long straight running board which reflects great care in designing and will serve to reduce wind resistance and thus increase efficiency.

One of the accompanying tables gives the more important weights, dimensions and proportions of these locomotives, while another table shows a comparison between the several lots of 4-8-4 type locomotives ordered at different times by the Lackawanna. A tabulation of the special equipment applied on these locomotives is also included.

Motive Power Requirements For High Speed Trains[1]

Part II

By G. I. Wright[2] and P. A. McGee[3]

Calculations of operating costs —Traffic density to justify electrification—Handling suburban traffic

THE following assumptions as to costs of motive power and rolling stock, fuel or power and other expenses as well as train operating conditions have been made in order to arrive at train operating costs. Table V gives the unit motive power and rolling stock costs assumed; Table VI, fuel and power consumption and costs; Table VII, cost of fuel and power per 100 hp. miles.

Table V—Unit Costs of Rolling Stock and Motive Power

1	Steam locomotive cost per hp	27.50 to 46.00
2	Electric locomotive cost per hp	50.00
3	Distributed electric motive power eqpt. cost per hp	40.00
4	Oil-electric motive power eqpt. cost per hp	100.00
5	Steam conventional coach basic cost per ft	400.00
6	Electric and oil-elec. conven. coach basic cost per ft	450.00
7	Lightweight car basic cost per ft	500.00

Note.—Cost given in dollars. Horsepower is at driving wheels.

Table VI—Fuel and Power Consumption and Costs

Coal consumption steam locomotive	—4 lb. per hp. at dr.wheels
Electric power consumption	—1.00 KW hr. per hp. hr. dr. wheels
Fuel oil consumption-oil-elec. equipment	—0.6 lb. per hp. hr. dr. wheels
Unit coal cost	—$3.50 per ton in tender
Unit cost of elec. power-main line	—$.007 per KW hr. at receiving point
Unit cost of oil engine fuel	—$.045 per gallon

Table VII—Cost of Fuel and Power per 100 Hp. Miles

Free running speed	Schedule speed	Steam	Elec.	Oil-Elec.
70 m.p.h.	45.0 m.p.h.	$ .0140	$ .0144	$ .0072
85 m.p.h.	58.5 m.p.h.	.0107	.0110	.0055
100 m.p.h.	72.0 m.p.h.	.0087	.0090	.0045
125 m.p.h.	90.0 m.p.h.	.0070	.0072	.0036

Crew expenses—With head-end motive power a four-man train crew costing 20 cents per train mile is assumed. When power exceeds 3,500 hp. an additional locomotive crew is added with steam power, giving a total cost of 32 cents per train mile.

A three-man train crew with distributed electric or oil-electric power is assumed. This would cost 13 cents per train mile. When the oil-electric power exceeds 2,500 hp. an engine helper is added, increasing the cost to 20 cents per train mile.

These crew expenses are a minimum and are for comparative purposes only. Other crew expenses such as baggagemen, Pullman conductors and porters, common to all types of power, are not included.

Lubricants, water supplies and general expenses—Curve No. 4—These costs are usually compiled on a train mile basis. When, however, there is a reasonable uniformity in the locomotives handled the costs may be compiled on a horsepower basis.

Switching and terminal costs—Curve No. 5—These costs include switching charges with the maintenance and repairs of locomotives. It may amount to from 10 to 15 per cent of main line transportation costs. With self-contained power switching and terminal costs become a minimum. With oil-electric power, due to probability of much wye movement and lack of information, the same costs are assumed as with steam.

Enginehouse expense—Curve No. 6—The costs for steam were taken from known costs for locomotives of reasonably uniform horsepower.

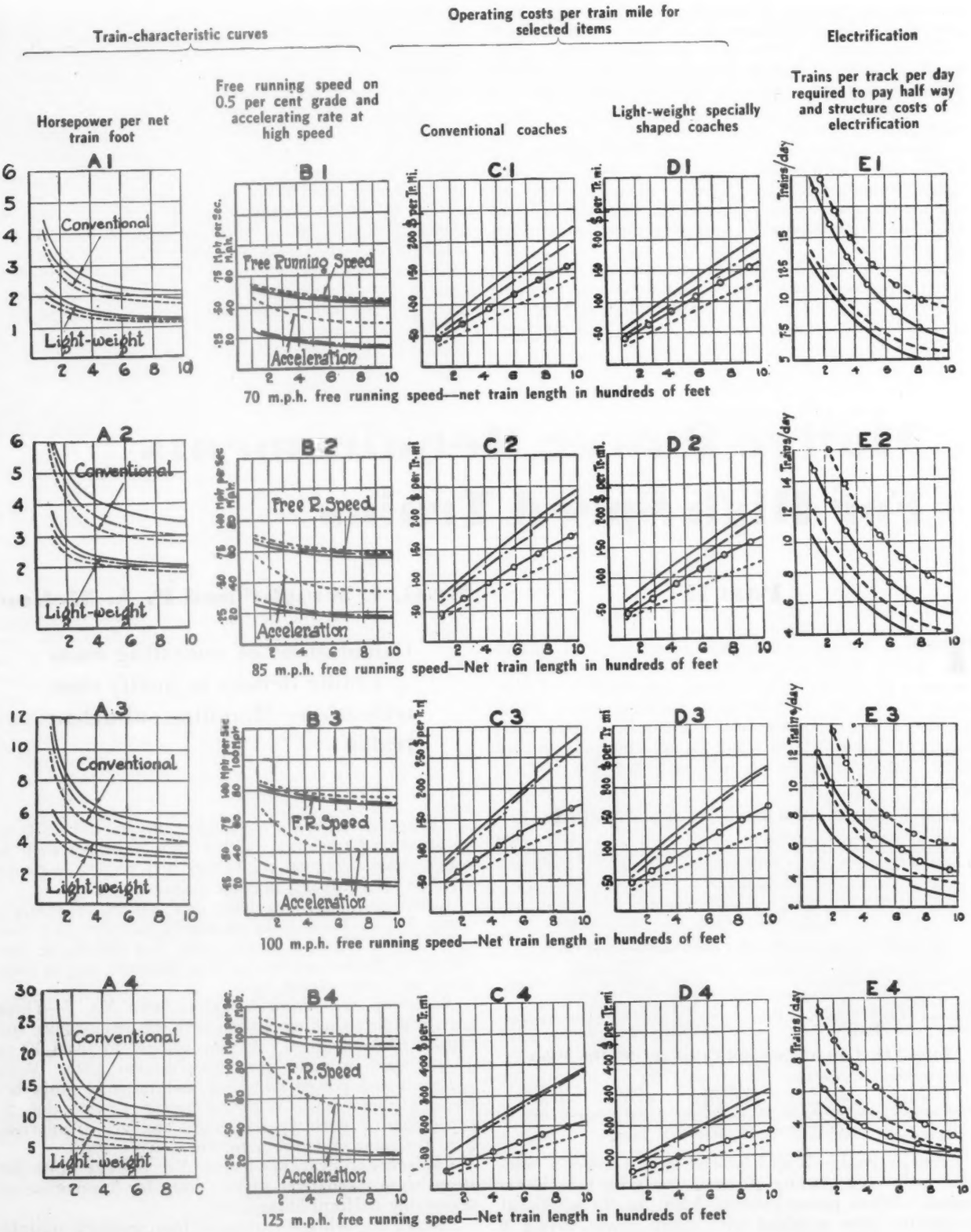
Electric enginehouse expense is from available records.

With oil-electric motive power there are no available records of value. In consequence values half those of steam were taken.

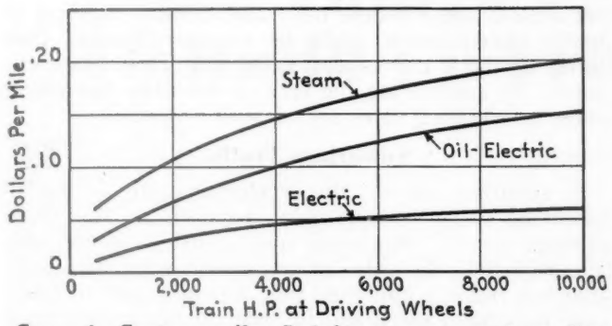
Locomotive and motive power equipment maintenance —Curve No. 7—Steam locomotive maintenance costs are from T. R. Cook's article in "Baldwin Locomotives" April, 1933.

Maintenance for electric operation is taken from records of motor car maintenance and includes all elec-

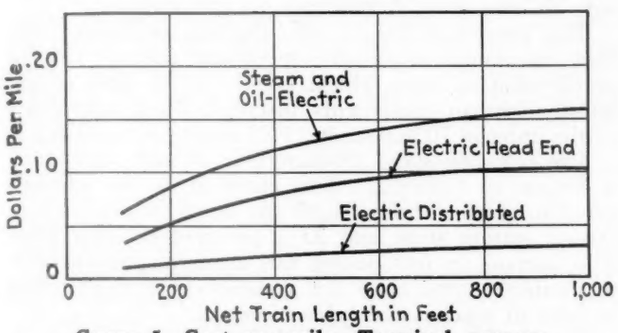
[1] Abstract of a paper presented before the New York Railroad Club, October 19, 1934.
[2] Chief electrical engineer, Reading Company.
[3] Assistant engineer, Reading Company.


Train-characteristic curves
Operating costs per train mile for selected items
Electrification
Horsepower per net train foot
Free running speed on 0.5 per cent grade and accelerating rate at high speed
Conventional coaches
Light-weight specially shaped coaches
Trains per track per day required to pay half way and structure costs of electrification
A 1
B 1
C 1
D 1
E 1
Conventional
Light-weight
Free Running Speed
Acceleration
70 m.p.h. free running speed—net train length in hundreds of feet
A 2
B 2
C 2
D 2
E 2
Free R. Speed
85 m.p.h. free running speed—Net train length in hundreds of feet
A 3
B 3
C 3
D 3
E 3
F.R. Speed
100 m.p.h. free running speed—Net train length in hundreds of feet
A 4
B 4
C 4
D 4
E 4
125 m.p.h. free running speed—Net train length in hundreds of feet
Curves A, B, C and D
Steam power.
Electric distributed power.
Electric head-end power.
Oil-electric power.
Curve E
Electric distributed power, conventional coaches.
Electric distributed power, with light-weight specially shaped coaches.
Electric head-end power, conventional coaches.
Electric head-end power, with light-weight specially shaped coaches.

Curves A, B, C, D and E



Curve 4—Cost per mile—Lubricants, water and supplies



Curve 5—Cost per mile—Terminal expense including switching

trical and mechanical apparatus associated with electric motive power.

No satisfactory maintenance cost for main line oil-electric equipment is available. In the absence of available data the same costs are assumed as with steam.

Car maintenance costs—Due to the fact that steam operation generally employs axle-driven generator sets with substantial batteries on individual coaches and electric and oil-electric distributed power supplies auxiliaries direct with minimum size auxiliary batteries, it is necessary to consider maintenance separately for the two types.

For a day coach with air conditioning and axle generator with battery, the basic maintenance cost would be approximately 3½ cents per 100 ft. car mile. With electric and oil-electric distributed power the cost would amount to 2½ cents per 100 ft. car mile.

Availability and yearly mileage—The availability may be represented by the yearly mileage expected. The yearly mileage will increase with increase in speed. The mileages with schedules requiring free running speeds of 70 and 85 m.p.h. are representative averages obtained today. Mileages with free running speeds of 100 and 125 m.p.h. are estimated values.

Table VIII—Availability and Yearly Mileage

		Head-end power		Distributed power	
	Speed	Steam	Electric	Electric	Oil-elec.
Loco.	70 m.p.h.	55,000	100,000	.....	.....
Car	70 m.p.h.	75,000	75,000	90,000	75,000
Loco.	85 m.p.h.	65,000	125,000	.....	.....
Car	85 m.p.h.	85,000	85,000	110,000	85,000
Loco.	100 m.p.h.	75,000	145,000	.....	.....
Car	100 m.p.h.	95,000	95,000	130,000	95,000
Loco.	125 m.p.h.	90,000	175,000	.....	.....
Car	125 m.p.h.	120,000	120,000	160,000	120,000

These mileages are averages and do not represent assignments where exceptional mileages might be obtained.

Fixed charges—Charges are taken at 11 per cent of the basic equipment costs. This amount is built up with 5 per cent interest charge, 4½ per cent depreciation and 1½ per cent for insurance and taxes. Fixed charges are based on yearly mileages shown on Table VIII.

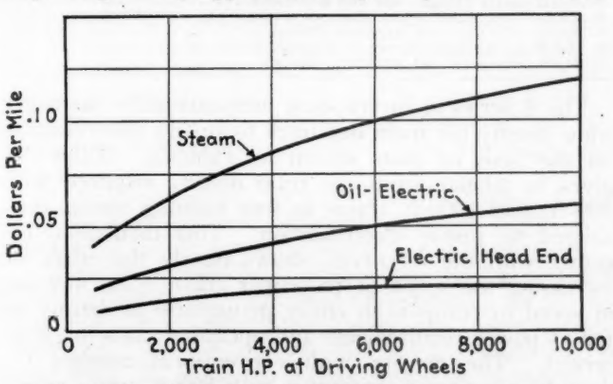
Estimates of operating costs are primarily for comparative purposes and are not exact for any particular application. Certain expenses common to all trains are not included in costs considered. Costs taken represent values which may be obtained on a road having a fairly level profile with a medium traffic density. Little is known regarding first cost or maintenance cost of equipment which may be operated at speeds over 100 m.p.h. so that values given for very high speeds must be looked upon as approximate estimates. With oil-electric equipment no standards have yet been established and weights and costs may be considerably affected by future developments. This reasoning also applies to some extent to other types of power.

Curves *C* and *D* clearly show the necessity of considering train size and free running speed in connection with operating costs. They also bring out the great economy secured with large-size trains. Comparison of *C* and *D* curves shows that the saving per train mile with light-weight special-shaped trains is small at low speeds. The effect of speed on operating cost is very marked with both steam and oil-electric power. Table IX shows the effect of speed between the two extremes considered with both conventional and light-weight special shaped trains.

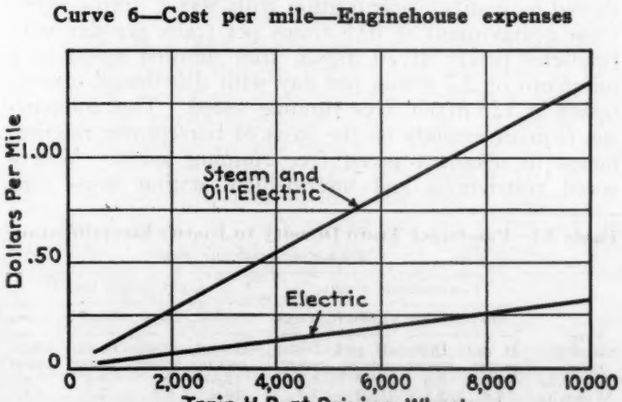
Table IX—Operating Cost per Train Mile

	Free running speed 70 m.p.h.				Free running speed 125 m.p.h.			
	100 ft.		1,000 ft.		100 ft.		1,000 ft.	
Type and class motive power	Conv.	Lt.wt.	Conv.	Lt.wt.	Conv.	Lt.wt.	Conv.	Lt.wt.
Steam head end..	$0.62	$0.58	$2.24	$2.04	$1.20	$0.82	$3.87	$3.15
Elec. head end...	.44	.40	1.65	1.60	.64	.49	2.115	1.80
Elec. distributed..	.33	.30	1.41	1.32	.49	.36	1.72	1.45
Oil-electric	.51	.46	1.99	1.82	1.18	.72	3.86	2.86

Savings indicated with electric power over steam are what would normally be expected at a free running speed of 70 m.p.h. The remarkable economy obtained with electric power at higher speeds, however, is probably not generally appreciated, especially with distributed



Curve 6—Cost per mile—Enginehouse expenses



Curve 7—Cost per mile—Motive-power maintenance

electric power. Further experience is required with oil-electric power before a satisfactory comparison can be made with steam operation.

Traffic Density to Justify Electric Operation

Since electric power is inherently the most economical for train operation and is preeminently satisfactory where very high speed is required, it is of interest to know the required traffic density to justify the large expenses necessary for transmission and distribution systems required with electric power. With main-line electrification it will generally be found that the factors which favorably affect passenger trains apply with equal or even greater force to freight trains. We may, in consequence, consider that half the way and structure charges are applicable to passenger train movements.

Transmission and distribution costs on main-line roads vary according to voltage of the system and availability of electric power. A high capacity transmission and distribution system could be installed today for about $25,000 per track mile. In connection with electrification new signals and communicating circuits are usually installed and certain alterations to bridges and structures are frequently required. Costs for these items may in the case of suburban electrifications amount to as much as transmission and distribution costs. With main-line electrification, however, these latter costs should be well covered by a round figure of $10,000 per main-line track mile. Total costs included in way and structure accounts for electrification per main-line track mile would then be as shown on Table X.

Table X—Transmission and Distribution Costs per Main Line Track Mile

1—Transmission and distribution costs	$25,000.00
2—Associated costs	10,000.00
3—Total way and structure costs	35,000.00
4—Yearly interest at 5 per cent	1,750.00
5—Yearly deprec. and taxes on trans. and distr. system	875.00
6—Yearly operating and maintenance	350.00
7—Total yearly charges way and structures	2,975.00
8—Deductions, maint. water and coal stations and enginehouses	150.00
9—Net yearly way and structure charges	2,825.00
10—Net daily way and structure charges	7.74
11—Half daily way and structure charges	3.87

. The *E* series of curves show necessary daily passenger train density per main line track to justify electrification on the basis of costs shown in Table X. Table XI gives in tabular form the train density required with 500-ft. and 1000-ft. trains at free running speeds considered to justify electrification. This tabulation, together with the *E* curves, shows clearly the effect of increasing the speed of passenger trains. An increase in speed of trains is in effect an increase in density as far as power requirements and operating costs are concerned. The density with conventional coaches required to justify electrification with 500-ft. trains varies from a maximum of 10.5 trains per track per day with head-end power at 70 m.p.h. free running speed to a minimum of 2.7 trains per day with distributed electric power at 125 m.p.h. free running speed. This comparison is made entirely on the basis of horsepower requirements to obtain a given free running speed. Where speed restrictions and intermediate station stops control a main-line schedule the traffic density required to justify electrification might be considerably less than shown on the *E* curves and Table XI. This is best explained by considering the case of suburban movement where accelerating rates are of such importance.

Table XI—Passenger Train Density to Justify Electrification

Trains per track per day

	Conventional trains				Light-weight trains			
	500-ft. trains		1,000-ft. trains		500-ft. trains		1,000-ft. trains	
Free running speed	H. end power	Distr. power	H. end power	Distr. power	H. end power	Distr. power	H. end power	Distr. power
70 m.p.h.	10.5	7.0	6.7	4.7	12.6	7.6	9.1	5.6
85 m.p.h.	8.4	5.5	5.2	3.7	10.9	6.7	7.2	4.3
100 m.p.h.	6.3	4.4	4.3	2.7	8.2	5.4	6.0	3.6
125 m.p.h.	3.2	2.7	2.1	1.7	6.0	4.4	2.9	2.3

Suburban Traffic

In suburban service, the accelerating rate is the all important factor in economic operation at any given schedule speed. Maximum speed must, however, also be considered. In order to accomplish some maximum suburban run in a minimum time it is necessary to attain some maximum speed and in order to accomplish some minimum or average run in a minimum time it is necessary to have some definite rate of acceleration.

The important indices of suburban equipment are, then, maximum permissible speed and average rate of acceleration to some critical speed. With some of the latest suburban equipments installed, these values are of the order of 70 m.p.h., and 1.25 m.p.h.p.s. to 30 m.p.h.

The schedule speed characteristic of such equipment is shown on Curve 2. This curve gives the schedule speed in m.p.h. for any length run up to four miles with 20-sec. station stops and 33⅓ per cent coasting time. The purpose in introducing this characteristic curve is to establish some basis for comparison with different weights of coaches and types of power.

The motive power required for suburban trains is based primarily on weight and to fulfill schedule speeds shown on Curve 2 an output of 8 hp. per ton is required at the driving wheels of the locomotive or coach. Taking the suburban coach and motive power weights and dimensions given with a passenger load of 175 lb. per foot, Table XII shows required horsepower output per net foot to meet schedules shown on Curve 2.

Table XII—Suburban Train Power Requirements

	Elec. distr. powr.		Stm. hd. end pwr.		Oil-elec. pwr.	
	Convt.	Lt.wt.	Convt.	Lt.wt.	Convt.	Lt.wt.
Hp. per ton	8	8	8	8	8	8
Hp. per net ft.	8.00	4.62	18.50	8.80	18.0	7.8
Hp. for 500-ft. train	4,000	2,310	9,250	4,400	9,000	3,900

It would not be economically feasible to employ steam power or oil-electric power of the magnitude shown in Table XII with conventional coaches and even with electric operation it becomes necessary to distribute the power in order to secure the necessary adhesion without unduly increasing total train weight. In view of these difficulties, suburban trains with steam power do not attempt to meet the schedule speeds shown on Curve 2 and for economic reasons steam schedules are adjusted to the lowest tolerable values.

An interesting comparison may be made between Table XII and the *A* series of curves. It will be found that the power required to meet suburban schedules shown on Curve 2 exceeds the power required for all train sizes considered in main-line service up to a free running speed of 100 m.p.h. and with steam and oil-electric power exceeds that required with 200 ft. trains at 125 m.p.h.

Steam-operated roads have little experience with motive power concentration such as that shown on Table XII and on the *A* curves for speeds of 100 and 125 m.p.h. Electrified suburban systems, however, operate with this power concentration and develop during periods of acceleration peak outputs of 10,000 hp. per train. There is, therefore, no technical difficulty in securing the necessary power for very high speed trains. Very high speed operation is largely a question of economics and public demand and response to such service.

Some Things That Must Be Done To Build Up Freight Traffic*

A Freight Traffic Officer frankly expresses to the Editor his opinion about the relation of equipment to freight traffic earnings

FREIGHT traffic on most railroads is the real money earner. For the railroads at large nearly 80 per cent of the operating revenues come from freight traffic; at least, that is the record for the past few years. There is no question but what the freight earnings have been greatly reduced by the competition of highway trucks. This was to be expected in some instances, because the truck is without question better fitted to handle certain classes of business; on the other hand, because the common carriers on the highway have not been subjected to regulation at all comparable to that under which the railroads have had to operate, and because the highway carriers have been subsidized because of rights-of-way provided for them largely at public expense, the railroads have been subjected to grossly unfair competition.

There is, of course, the strong possibility that Congress will remove this handicap at its present session. The railroads, however, must not lose sight of the fact that they will continue to face keen competition with other types of common carriers, and that they must use every effort to improve their services and reduce costs if they are to regain lost traffic and hold their own.

What Mechanical Department Can Do

In what ways, if any, can the mechanical department assist in this effort? This question was propounded to a freight traffic officer, in the hope that it might bring forth constructive suggestions.

"In the first place," replied the Freight Traffic Officer, "I realize perfectly well that the mechanical department is largely helpless, because it is unable to secure funds with which to do all that its officers believe should be done, either for maintaining and repairing the equipment or purchasing new equipment. In my opinion, however, mechanical department officers should consistently and determinedly drive home to their superior officers what they believe to be the probable needs, so far as the maintenance of present equipment and the designing and building of new equipment is concerned. Surely, no one understands such matters better than these officers."

"The roads seem to be getting along fairly well in handling freight traffic under present conditions," I said. "Do you anticipate increased business in the near future?"

"My own opinion," replied the Railroad Traffic Officer, "is that we are definitely headed for better business, and that in all probability we will be called upon to transport a very much larger amount of freight in 1935 than in 1934. I am concerned about the fact that we may not have sufficient equipment available to meet the demands that may be made upon us, and this is particularly true in the providing of freight cars for the safe handling of high grade and perishable commodities. What will happen if we find that within a limited period we shall have to greatly increase the number of cars in good order? I am told, for instance, that cars, that we might have reason to believe could be restored to condition quickly, have been robbed of so many of their parts to keep other equipment going, that it may be necessary almost to rebuild them before putting them back in service. If this is true, and if we do face any considerable pick-up in traffic, then it seems to me that it is up to the mechanical department to bring these facts about the conditions of the equipment clearly and forcefully to the attention of the managements."

"In a broad way, what other suggestion would you make to the mechanical department?" I inquired.

Reduce Weight of Equipment

"If we are to be successful in competing with other types of common carriers," replied the Railroad Traffic Officer, "we must considerably reduce the costs of transportation by rail. I am not one of those who favors a general increase in freight rates. I believe that if there is any way in which it can possibly be done, we ought to find ways and means of reducing our costs in order to keep the freight rates as low as possible.

"I am not an expert on the costs of operation," he continued, "but obviously we can make savings if we can reduce the weight of the equipment. The A.R.A. standard box cars are, of course, a step in the right direction, but it seems to me that the saving in weight is pitifully small, as compared to what may be done by taking advantage of some of the new steels and special types of construction. True, when we go to new equipment it will take considerable time to get enough of it in service to have a marked effect upon costs and, yet, the sooner we get started on such a program, the sooner we will be in a position to meet more effectively some of the competition to which we are being subjected. If business does pick up very fast we shall have to order a lot of new equipment, and it will be just too bad if in doing so we buy cars that are not of the lightest possible weight consistent, of course, with reasonable first costs."

"It will take money to buy new equipment," I suggested, "and you know the railroads are hardly in a position to expend great amounts for new equipment."

"That may well be," replied the Railroad Traffic Officer, "but if you take into consideration the savings that may be made by the lighter and more modern equipment, I have an idea that the railroads will be warranted in going to rather extreme measures in scrapping old equipment. Such measures on their part will probably meet with the approval by the Administration, which may help to finance the purchase of new equipment, and thus go a long way toward stimulating the durable goods industries, which, as you know, are vital to recovery in this country. One of your own publications, the Railway Age, very clearly and forcefully demonstrated this in its December 1 issue."

"These things are largely beyond the power of the mechanical department to control," I suggested. "The suggestions you are making should go to the executives and the boards of directors."

"Possibly you are right," replied the Railroad Traffic Officer, "but nevertheless, the mechanical department officers have a duty to do their full part in impressing the management with the possibilities of weight saving and modern construction in freight equipment."

* Seventeenth of a series of interviews with men outside the mechanical department, commenting in a constructive way on the possibilities of that department.

Side view, plan and sections of Pressed Steel Car Company's light-weight hopper car

Bessemer Orders Hoppers of Pressed Steel Company's Design

100 light-weight cars ordered from the design developed by the builder and incorporated in a car exhibited in several cities during the month of November

THE Pressed Steel Car Company had on exhibition during the month of November a hopper car with a nominal capacity of 69 tons and a light weight of 30,000 lb. U.S.S. Cor-Ten steel, with a yield point between 50,000 and 60,000 lb. per sq. in., was used throughout the car body, both in the rolled sections and plate, the corrosion-resisting quality and high tensile strength of the Cor-Ten steel having been utilized to reduce the thickness both of the plate and structural sections. Alloy steel was also employed to reduce the sections and weight of the truck side frames and bolsters, as well as of other castings. Thus, it was possible to build a car which is carried on four-wheel trucks with 5½-in. by 10-in. journals with a load limit of 139,000 lb. One hundred cars of this design have recently been ordered by the Bessemer & Lake Erie.

The car body is 34 ft. 10 in. in length inside by 10 ft. $4\frac{15}{16}$ in. overall and the top is 10 ft. 8 in. above the rail. The capacity is 2,605 cu. ft. with a 10-in. heap which provides a ratio of pay load to gross load of 81.9 per cent when loaded with coal at 52 lb. per cu. ft., or 82.2 per cent when the car is loaded to the axle-load capacity.

The car body, which has three hoppers, is built up on an underframe, the principal member of which is a center sill of the new A.R.A. double Z-section. These sections, rolled from Cor-Ten steel, have been reduced in thickness to $\frac{5}{16}$ in. for the top flanges and to $\frac{41}{64}$ in. for their bottom flanges. The complete center sill weighs 58.14 lb. per foot, instead of 72.42 lb. per ft. for the standard sections, and the cross-sectional area has been reduced from 21.3 sq. in. to 17.5 sq. in. The two Z-sections are joined by welding continuously throughout their length. The side sills are rolled angles, as are also the corner posts. The end sills are pressed angles.

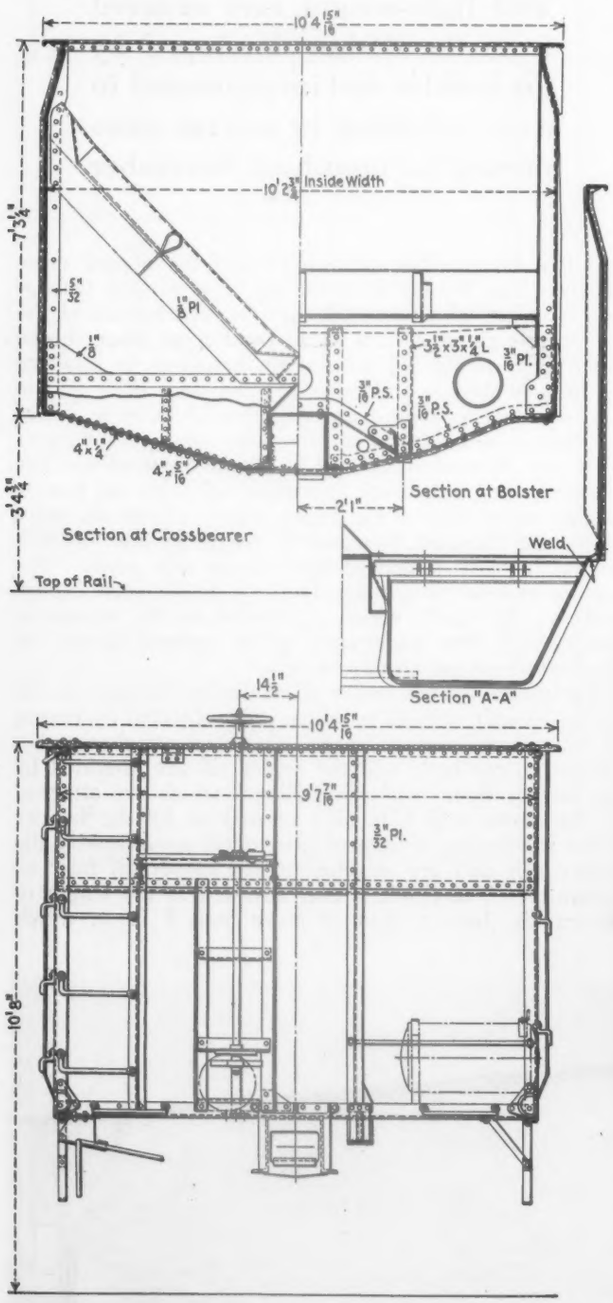
There are four principal cross-members: The bolsters and two intermediate crossties under the hopper cross ridges. The bolster is made up of a vertical web of $\frac{3}{16}$ in. plate which extends up from the bottom of the center sills about 2 ft. 9 in. to the hopper floor sheets. This plate, reinforced with angle pressings, is attached by pressed flanges and angles to the floor plate and to a ¼-in. bottom cover plate which is 17 in. wide where it passes under the center sill. The edges of the cover plate are flanged down ⅞ in. to add stiffness. The crossties are ⅛-in. plate extending up from the bottom of the center sills to the cross ridges. Near the sides of the car they are increased in height to add stiffness where they are joined to the crosstie side posts. The bottom member of the crossties is a double plate, ¼ in. and $\frac{5}{16}$ in. thick, which is riveted to the center-sill flanges and filler diaphragm end to pressed flanges on the bottom of the crosstie web.

To insure against center-sill deflection because of the increased unit stresses to which it is subjected by reason of its reduced sectional area, additional attachment between the car body and the center sill are provided by the hopper floor reinforcing Z-bars which are attached to the center and side sills as well as by the hopper chute reinforcing Z-bars which extend across under the center sills and are attached to the center-sill filler or separator. The result is that nowhere in the length of the car is there a span of more than 5 ft. in which

Sample light-weight hopper car built by the Pressed Steel Car Company

the center sill and body structure are not tied together.

Riveted to the ends of the bolsters are special pressed Z-section posts, the purpose of which is to reduce the width of the hopper at the end panels to provide a recess for ladders and grab irons. The side posts at the crossties are T-sections built up of angle pressings and riveted to the ends of the crosstie web plates. The top



End view and cross sections of light-weight Cor-Ten steel hopper car

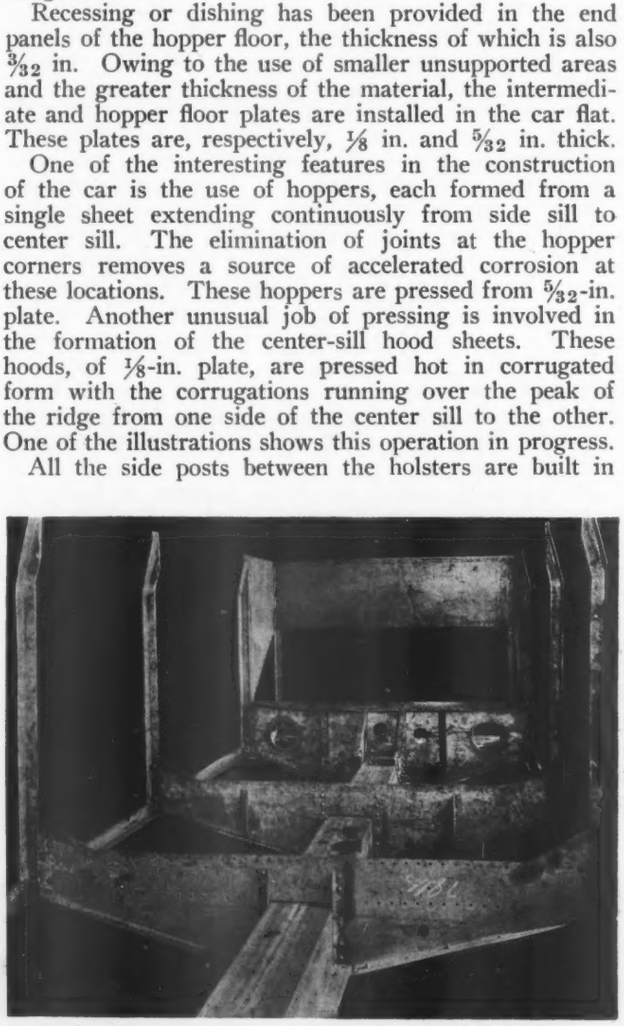
members of the sides and ends are 5-in. by 2½-in., 7.3-lb. bulb angles.

Among the special features of the car body is the shallow outward recessing or dishing of the side-sheet panels. The side sheets are formed in four pieces. Two of these extend from the ends of the car to the bolster side posts. The others extend from the bolster side posts to the center side posts, where they overlap so that the riveting through both side-post flanges passes through each plate. These plates are formed under special dies which, in addition to forming the inward slope at the tops of the panels, effect the slight outward recessing of the vertical portion of each panel. This not only adds stiffness to the sides of the car, which are formed of $\frac{3}{32}$-in. plate, but also effects a considerable reduction in the maximum stress to which the material is subjected when the loaded car is turned over in a car dumper. The small end panel of each end side sheet is kept a flat surface in order not to interfere with ladder-rung clearance.

Recessing or dishing has been provided in the end panels of the hopper floor, the thickness of which is also $\frac{3}{32}$ in. Owing to the use of smaller unsupported areas and the greater thickness of the material, the intermediate and hopper floor plates are installed in the car flat. These plates are, respectively, ⅛ in. and $\frac{5}{32}$ in. thick.

One of the interesting features in the construction of the car is the use of hoppers, each formed from a single sheet extending continuously from side sill to center sill. The elimination of joints at the hopper corners removes a source of accelerated corrosion at these locations. These hoppers are pressed from $\frac{5}{32}$-in. plate. Another unusual job of pressing is involved in the formation of the center-sill hood sheets. These hoods, of ⅛-in. plate, are pressed hot in corrugated form with the corrugations running over the peak of the ridge from one side of the center sill to the other. One of the illustrations shows this operation in progress.

All the side posts between the holsters are built in



The car frame, showing the bolster and crossties

two parts—one inside and one outside the car. The outside sections of the posts are all shallow U-pressings of ⅛-in. plate, the purpose of which is to protect the bulges in the side-sheet panels when the car is handled in a car bumper. The flanges of these sections are riveted through the side sheets to the flanges of the inside posts. Five intermediate posts on each side of the car are of deep U-section formed from $\frac{3}{16}$-in. plate. By this construction the edges of the relatively thin side-sheet panels are rigidly supported between the two post sections throughout their height.

The diagonal braces which stiffen the side of the car against transverse pressure at the crossties are pressings of ⅛-in. plate The upper edge of each member is flanged over and closed in two operations, after which the edge is welded to the web to form a light, stiff

tubular member which offers no obstruction to the flow of material, whether dumped from the top or through the hoppers.

The hopper-door frame is formed of 3½-in. by 2½-in. by ¼-in. angle, with the leg parallel to the hopper sheet projecting beyond the edge of the sheet. This forms a stiff, true edge over which the door pans, pressed from 5/32-in. plate, are tightly closed. Each pair of doors is reinforced by a 5-in. by 2¾-in. by ¼-in. pressed-Z door spreader. The door hinges are of high tensile alloy steel.

Principal Dimensions of the Pressed Steel Car Company Light-Weight Hopper Car

Length over striking plates	35 ft. 10 in.
Length inside	34 ft. 10 in.
Width inside	10 ft. 2¾ in.
Width overall	10 ft. 4-15/16 in.
Height, rail to top of sides	10 ft. 8 in.
Distance between truck centers	25 ft. 10 in.
Truck journals	5½ in. by 10 in.
Truck wheel base	5 ft. 6 in.
Light weight	30,000 lb.
Car body	17,800 lb.
Trucks	12,200 lb.
Load limit	139,000 lb.
Capacity, level full	2,328 cu. ft.
Capacity, 10-in. heap	2,605 cu. ft.
Ratio capacity pay load to gross weight	82.2
Ratio capacity coal load to gross weight (coal at 52 lb. per cu. ft.)	81.9

Although not a major factor in the car structure, welding has been used in a number of places. The ends of the longitudinal hoods are welded to the floor and to the cross ridges. Reinforcements are welded to the hopper sheets where the hopper-door locks are attached. The hopper-door frames are welded to the side sills and at their upper ends to the hopper sheets. The door hinge butts are also welded to the door-frame angles.

The two trucks weigh 12,200 lb. Compared with the trucks under the standard A.R.A. steel box cars, this represents a saving of about 3,500 lb. per car. The side frames and bolsters conform to A.R.A. specifications. They are cast of a high-tensile-alloy steel, advantage of which has been taken to reduce the thickness of the sections. The side frames are the double-truss type with journal boxes cast integral.

Each hopper is pressed from a single plate

An interesting feature in the construction of the truck is the special spring plank design. Partly to save weight and partly to provide greater flexibility for adjustment to warped track conditions, the spring plank is made up of two short pressed channel pieces, one at each end to serve as a spring seat, which are joined across the truck by a 6-in. by 5/32-in. plate riveted to the channels at each end. Brake-beam safety angles are also riveted to the inner ends of the channel sections of the spring plank.

The corrugated center-sill hood sheets are hot pressed from ⅛-in. steel plates

A material saving of weight was effected in the wheels and axles. The A.R.A. 5½-in. by 10-in. axles were hollow bored 3½ in. in diameter, with a reduction of 920 lb. per car. By the use of one-wear rolled-steel wheels a reduction of about 1,600 lb. per car was effected as compared with cast-iron wheels.

Aside from its use in the truck castings, high-tensile steel was employed for the striking castings, the body-bolster center braces, side-bearing braces body center plate, coupler yoke, door hinges and the door locks. In all cases advantage was taken of the improved physical properties of the steel to effect weight reduction. The brake levers, brake rods and brake-lever guides are of Man-Ten steel. The brake reservoir is formed of Cor-Ten steel, welded. Cor-Ten steel rivets were used through the structure. These ranged in size from ⅜ in. to ⅝ in., with ¾ in. rivets used for the draft attachments.

The important items of special equipment incorporated in the Pressed Steel demonstration car are the AB brake, furnished by Westinghouse, Edgewater ring-spring draft gears, Stucki roller side bearings, Wine door locks and the A.R.A. geared type hand brake. The principal dimensions and data are shown in the table.

Determining Car-Wheel Eccentricity*

By W. E. Gray

Part II—Two types of gages for accurately checking the roundness and concentric mounting of car wheels either at the wheel shop or while under cars

SINCE steel wheels are either practically round before they are bored for mounting or the treads are trued up after the wheels are mounted, there is no excuse for the treads of these wheels not being concentric with the journals of the axles within very small limits. If the work of mounting is properly done there should not be more than .020 in. difference in the radial distance from journal surface to wheel tread at any two points around the circumference, and it is possible to hold the variation to .010 in.

On cast steel wheels having a hardened tread which is not machined after mounting, nice boring work must be done in order to have the bore concentric with the tread and perpendicular to the plane of the wheel, and nice axle work must be done in order to have the wheel seats and journals concentric, but these are conditions that are not impossible of fulfillment with a high degree of accuracy. The variations quoted are amply sufficient to allow for unavoidable or uneconomically controllable factors such as spring in the machines and tools, imperfect centers in the axles, etc.

Table IV gives the condition of four pairs of wrought steel wheels with turned treads and four pairs of cast iron wheels with treads ground after mounting, and it is seen that they are all within these limits. The cast iron wheels included in this group were ground on axle centers. Some grinding machines carry the mounted wheels on the axle journals during the grinding operation and this should give even greater accuracy.

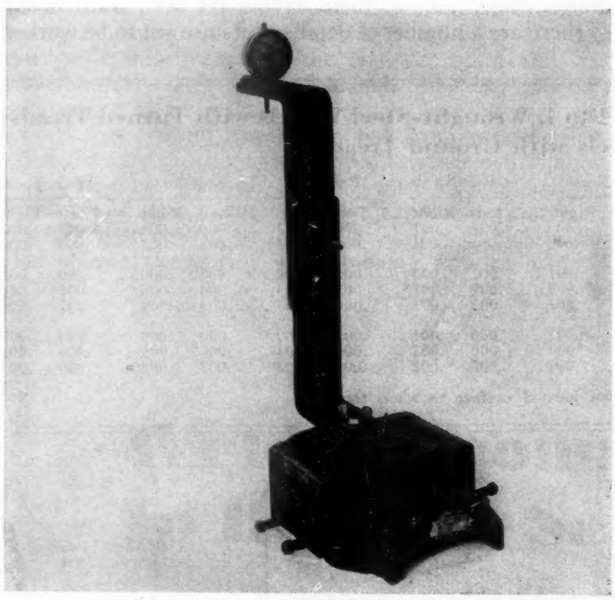
For making measurements of the trueness of wheels not under a car, the gage shown in the half-tone illustrations has been found to give very accurate results. All of the wheel-concentricity measurements reported in this article were made with a gage of this type and the wheels reported in Table 1, Part 1, had previously been checked on axle centers in a lathe. The agreement between the two checks was very close. The gage consists of an Ames dial, reading to thousandths of an inch, mounted on a bracket which is fastened to a journal brass for a base. The bracket, which is adjustable to take care of different sizes of wheels, is of such shape that when the brass rests on the journal the dial spindle is held in contact with the tread of the wheel. By rolling the pair of wheels, readings of the dial can be made all around the circumference of the wheel.

A new journal brass should be used for this gage in order to have a good surface to rest on the journal. It has been found that for checking axles with used journals, it is advisable to have the central part of the babbitt broached out about 1/64 in. so that the brass contacts the journal on two strips of babbitt about ½ in. wide at each end. This will prevent it from tipping on a crowned journal, which would give erratic readings. It is also advisable to have a small projection on the outer edge of the brass so that it can be held against a journal collar that is worn tapered without changing the distance of the dial spindle from the edge of the wheel rim. This projection should be about ⅛ in. high and can be a small piece of sheet brass soldered to the end of the journal brass in such a location that it contacts the journal collar above the fillet in the corner. Where a large amount of checking is to be done, it might be advisable to construct a special base to be used instead of a journal brass, as this could include all the essential features provided by the brass and be much lighter in weight.

In preparing to use this gage, the pair of wheels should be placed on a track that is free from dirt and the wheel treads and journals should be thoroughly cleaned. A stiff wire brush is the best thing for cleaning the treads, supplemented wherever necessary by a scraper. The journals should be wiped with a clean cloth after the treads

* Part I of this article, containing extensive data on the present, often highly eccentric mounting and out-of-round condition of many car wheels, was published on page 430 of the December, 1934, *Railway Mechanical Engineer*. The gages were developed and test measurements made by Mr. Gray as a representative of the Engineering Experiment Station, Purdue University, Lafayette, Ind.

are cleaned, and the brass, which forms the base of the gage, should be carefully wiped free of all dust and dirt before it is placed on the journal. If it is desired to keep a record of the measurements the circumference of the wheels should have reference marks placed on them before starting to take measurements. Eight marks on each wheel are sufficient, these to be spaced equal distances around the circumference. The marks on each wheel should be in line with those on the other wheel, and they should be numbered from 1 to 8, being careful to see that the direction of numbering on each wheel is such that corresponding numbers on the two wheels are in line. These marks can be placed on the outer rims



New type of accurate wheel concentricity gage used to make all the wheel concentricity measurements reported in this article

of the wheels with chalk, and with the exercise of a little care may be placed accurately enough without the use of a template. If it is desired to recheck the wheels after they have been in service, the reference marks should be painted on the inside of the rim, and they will then be available when the wheels come in for recheck.

With the wheels properly prepared, the gage can be placed in position on the journal, as illustrated, care being used to see that there is no dirt on the journal or gage base. The bracket of the gage should be adjusted so that the dial spindle is perpendicular to the axis of the wheel and contacts the tread at a point 2⅝ in. in from the outer edge of the rim, and the end of the gage base contacting the journal collar. The dial, which must have a range of ¼ in. and should preferably have a range of ½ in., should read somewhere near the middle of its range, this also being adjustable through the bracket. One man should straddle the axis inside the wheels so that he can roll them under the direction of the man who is reading the gage. The man who rolls the wheels can also keep any loose dirt wiped off the tread ahead of the dial spindle. While the wheels are being rolled, the man who reads the dial should grasp the base of the gage in order to prevent it from rotating and dropping off the journal. Stop the wheels with one of the reference marks on top and be sure the gage will remain in position before letting go of it. Also be sure the base is contacting the outer journal collar so that the readings will always be taken on the coned portion of the tread at the same distance from the rim of the wheel at all points.

All readings should be taken with the gage resting on the journal without any pressure being applied to it by the observer. When the reading is obtained for one reference mark, the observer should grasp the gage so as to hold it in contact with the journal while the wheels are slowly rolled until the next reference mark comes on top. The observer should watch the dial indications while the wheels are being rolled in order to note if the trend of the readings is always in the same direction between two reference marks or if there is a change in trend at any point between them. In the former case, no reading need be taken between reference marks, but if the dial indicates a change in trend of the trend, the maximum or minimum point, as the case may be, should be located and a reading taken at this point. For reference, this point may be designated as a decimal fraction of the distance between the two adjacent reference marks, the fraction being easily estimated. Continue all the way around the wheel this way, stopping to make readings at each reference mark and at any maximum or minimum points between reference marks. As a final check on

Method of using the new type of wheel concentricity gage

the accuracy of the work, make the last reading on the first mark that was read. If everything is in order, this reading will check the first reading within .001 in. or .002 in. If the check is not this close, look for errors in the work.

Checking Wheels While Under Cars

The method just described is applicable with accurate results to a pair of wheels that is not under a car. It may be used for checking the work of wheel shops or for de-

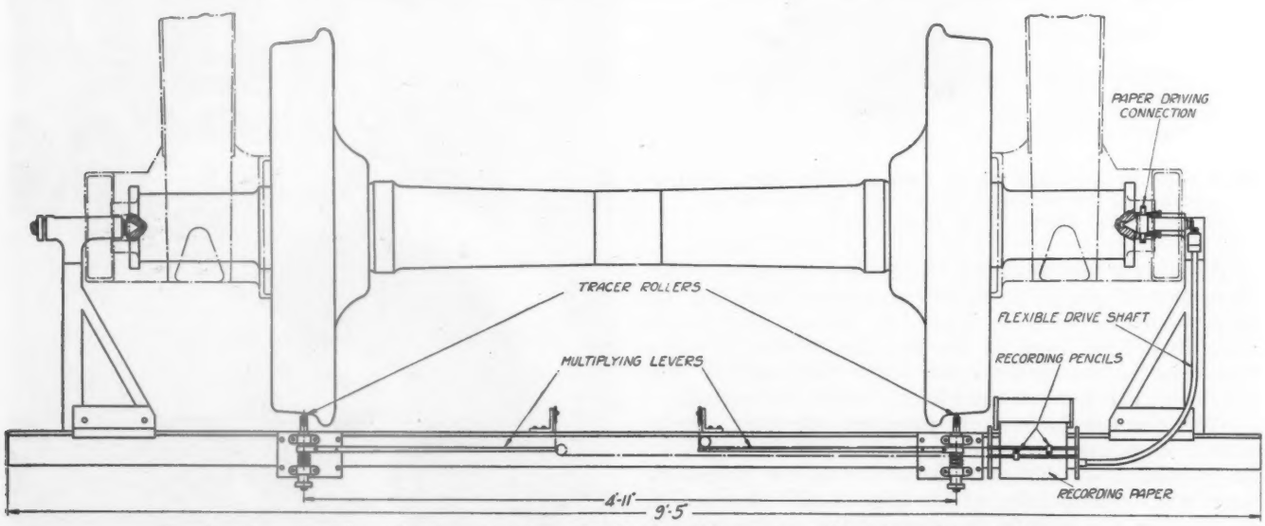
termining whether a pair of wheels is fit to be continued in service. Where it is desired to check a pair of wheels without removing them from a car, another gage has been designed, as shown in the drawing. This gage has the form of a large C-clamp which straddles the wheel and axle, centers being provided to attach the clamp in the axle center holes after the journal-box lids have been opened. The clamp carries two hardened tracer rollers, one for each wheel. These ride the treads of the wheels, being held in contact with them by spring pressure. The in-and-out motion of these tracer rollers caused by wheel eccentricity as the wheels are revolved is multiplied suitably and operates pencils which record the motion on a strip of paper. This paper is driven by the turning of the wheels through a mechanism which reduces the linear motion to a suitable scale, and in this way an autographic record of the wheel eccentricity is secured as the wheels are revolved. The gage is designed to be adjustable to handle different sizes and weights of wheels.

To use this gage, it is proposed to attach it to a pair of wheels under a car and suspend the frame of the clamp from the car center sill by a chain so that the car can be moved with the gage in position. The gage can be attached to inside wheels of a four-wheel truck as well as to outside wheels. The pencils are placed in recording position and the car is then moved slowly, either with a car mover or an engine, until the pair of wheels has made at least one revolution. A record of the eccentricity of both wheels of the pair is thus secured simultaneously on the strip of paper. This gage is still in the design stage, none of them having yet been constructed, so there are a number of details of its use yet to be worked

Table IV—Wheel Eccentricity Measurements—Pairs 1 to 4, Wrought-Steel Wheels with Turned Treads; Pairs 5 to 8, Cast-Iron Wheels with Ground Treads*

Mark No.	Pair No. 1		Pair No. 2		Pair No. 3		Pair No. 4		Pair No. 5		Pair No. 6		Pair No. 7		Pair No. 8	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
1	.002	.021	.000	.011	.016	.013	.004	.002	.007	.001	.006	.002	.000	.006	.002	.002
2	.012	.019	.002	.011	.017	.013	.001	.000	.004	.001	.006	.003	.001	.003	.000	.000
								2.5–.005								
3	.017	.014	.002	.008	.014	.010	.000	.001	.007	.000	.005	.004	.003	.000	.000	.001
4	.018	.014	.004	.004	.008	.005	.004	.005	.009	.001	.002	.004	.006	.006	.002	.002
5	.014	.006	.005	.004	.001	.002	.007	.007	.003	.001	.000	.003	.004	.009	.002	.003
		5.7–.000		5.3–.000		5.5–.000										
6	.009	.004	.005	.003	.000	.001	.006	.003	.000	.001	.003	.000	.000	.009	.000	.002
7	.004	.010	.001	.006	.002	.004	.005	.004	.000	.002	.004	.004	.006	.005	.000	.001
8	.000	.011	.002	.012	.012	.009	.004	.003	.007	.002	.005	.002	.003	.008	.000	.001

* All measurements are in inches above the minimum radial distance from journal surface to wheel tread.



Device for checking the eccentricity of wheels without removing them from under cars

Table V—Wheel Eccentricity Measurements—Four Pairs of Cast-Iron Wheels When New and After 20,000 Miles of Service*

Mark No.	Pair No. 1				Pair No. 2				Pair No. 3				Pair No. 4			
	left		right		left		right		left		right		left		right	
	New	After 20,000 miles	New	After 20,000 miles	New	After 20,000 miles	New	After 20,000 miles	New	After 20,000 miles	New	After 20,000 miles	New	After 20,000 miles	New	After 20,000 miles
1	.035	.037	.001	.004	.045	.044	.024	.016	.000	.001	.028	.028	.011	.009	.000	.000
2	.033	.038	.011	.008	.034	.036	.028	.022	.016	.016	.059	.045	.015	.019	.000	.003
3	.004	.006	.022	.022	.034	.023	.029	.025	.027	.030	.061	.066	.023	.026	.032	.035
					3.6-.033										3.5-040	3.5-044
4	.000	.000	.000	.000	.017	.017	.030	.026	.037	.042	.056	.057	.028	.024	.024	.024
5	.000	.006	.003	.003	.003	.000	.022	.025	.016	.012	.056	.052	.027	.016	.046	.048
										5.7-.000						
6	.002	.007	.018	.019	.000	.000	.010	.016	.002	.007	.060	.058	.035	.016	.025	.029
7	.009	.006	.024	.030	.029	.034	.011	.012	.025	.009	.043	.046	.000	.000	.035	.044
							7.4–.000	7.4–.000								
8	.023	.023	.021	.027	.041	.039	.016	.013	.007	.009	.000	.000	.003	.002	.010	.014

*All measurements are in inches above the minimum radial distance from journal surface to wheel tread.

out. None of these should prove impossible of solution and the result will be a gage that will give correct information on the trueness of a pair of wheels without removing them from the car.

With a means of obtaining this information readily, it should be possible to inaugurate a program of replacing wheels that are too much out of round or eccentric. Very little has been done along these lines in the past because of the difficulty in obtaining accurate measurements of wheel conditions. In such a program, it would be logical to set a rather high limit of eccentricity at first and change all wheels which exceeded this limit, then as progress was made the limit could be reduced and wheels not falling within this lower limit could be changed. Meanwhile, if all new wheels turned out of the wheel shops were as accurate as possible, the situation would constantly be improved until the goal of round and true wheels under all cars were attained. In starting such a program, a large amount of help in locating cars with wheels that are not true can be had from watching cars while they are moving at low speed in yards or terminals. A car that has even one pair of wheels excessively out of true will bounce badly at low speeds, the exact speed depending somewhat upon the load in the car. Any cars that bounce excessively when moving at speeds of six to eight miles per hour should be investigated for bad wheels.

In exercising control over the work of the wheel shops, the gage first described would prove indispensable. Periodic checks of finished pairs of wheels could be made, and, if any of the machines had become out of adjustment, this condition could be corrected before a large number of poor wheels had been turned out. An eccentrically mounted wheel starts out under a serious handicap because it is not only subjected to heavier loads caused by bouncing of the car body which it helps to produce at certain speeds but it is liable to slide flat because the brake shoe grabs the high spot. If a pair of wheels are fairly true when they leave the wheel shop, they have a much better chance of remaining that way in service. Table V shows concentricity measurements of four pairs of new cast-iron wheels when they left the wheel shop and the same measurements on these wheels after they had made about 20,000 miles. These wheels were turned out of the wheel shop in what would be considered good shape for cast-iron wheels and the measurements show that they remained in practically as good shape for the first 20,000 miles of their service. There has been no further opportunity to check their condition after additional service.

Welded Cromansil Structures In Railway Service

By E. J. Charlton*

Parts fabricated by welding not only permit weight reduction but proper stress distribution

EVOLUTION of designs for light-weight trains powered for high-speed service has naturally required drastic weight reductions in all of their component parts. In meeting the requirements of light weight in high-speed service, designers first utilized welded Cromansil steel construction in the complete engine frame, including the engine crankcase and water jacket, for the power plant of the first of the high speed, streamlined trains, that was built for the Union Pacific System by the Pullman Car & Manufacturing Corp. The engine, a distillate burning, carbureting type developed by the Winton Engine Company, is a 12-cylinder V-type with cylinders 7½ in. in diameter and having an 8½ in. stroke. The engine is rated at 600 hp., at 1,200 r.p.m., and some idea of the weight reduction effected through efficient design and the use of welded Cromansil steel construction in the engine crankcase is indicated by the fact that the weight ratio of the engine is 16 lb. per b.hp.

On the "Zephyr", built by The E. G. Budd Manufacturing Company for the Chicago, Burlington & Quincy, the internal unit which in functional comparison corresponds to the bed of a steam locomotive is the underframe of the power car. It carries the engine, generator, compressor, batteries, and controls, with a weight of approximately 60,000 lb. for engine and generator. This underframe weighs only 6,060 lb. as built in welded Cromansil steel. This extremely high ratio between weight of the structure and the load it supports was made possible by the utilization of an efficient design and fabrication by welding from Cromansil steel. Two hundred four pieces of Cromansil steel, flame cut to shape from rolled plate of the required gage, were formed where necessary and assembled and welded into the one piece structure. The underframe is 25 ft. 3½ in. in length, 8 ft. 8 in. in width, and was welded principally from plates 5/16 in. in thickness. It forms the bed of the front half of the first car of the train and is joined at the rear to the stainless-steel structure forming the balance of the car. In the preparation of the many small component parts and in the assembly and welding procedure, exercise of great care was necessary because the underframe was the first structure of such shape and weight-volume ratio that had been attempted with the welding method of fabrication. Considering the complexity of the service conditions imposed on the structure—the 600 hp. Winton Diesel engine and generator depending upon it for their stability in operation, the stresses induced by movement over the average roadbed and accentuated by operation at high speeds, the lateral thrust due to curvature in the track and possible collision in service, the remote contingency of dragging the train through the coupler connected directly to the frame by the usual draft-gear arrangement—the construction of the underframe in the

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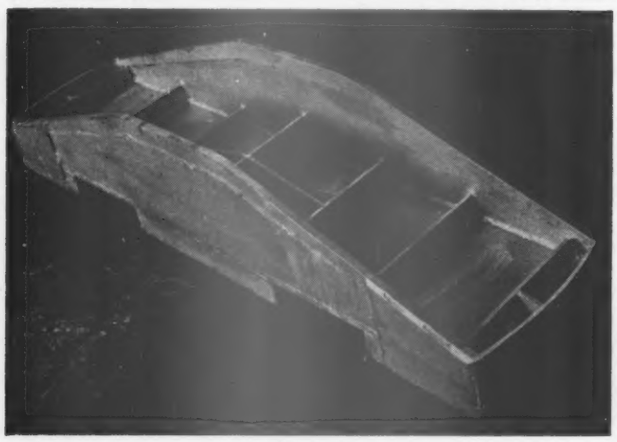
conventional structural steel, fabricated by riveting, was wholly impractical. Standard structural shapes would have produced angularity in the completed unit, resulting in possible stress concentration points which could not be permitted. Every rivet would have been a possible starting point for localized corrosion. Production of the underframe in cast steel was evidently an impossibility because of the weight requirements.

It will be observed that the contours of the underframe



A steel bolster fabricated by welding

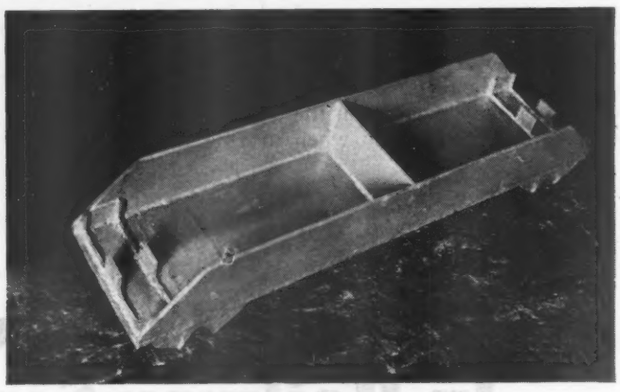
depart radically from the conventional. Every effort was made to utilize the inherent flexibility of welded construction in the production of a structure free from sharp changes in configuration at critical points. The design incorporates extremely moderate changes in contour to avoid concentrations of stress. The mutual interaction of adjacent members, introducing a high degree of redundancy, is an important element in the functioning of the structure as a single unit rather than as a connected assembly of individual members.

An incidental but interesting factor in the fabrication of such a unit in welded steel is the ease with which design revisions, decided upon after fabrication has begun, are carried into effect, even on the day of shipment from the welding shop. It follows, of course, that any changes deemed necessary in units constructed at later date can be effected without the inhibiting influence of existing patterns or molding equipment, or on the other hand, by the sizes and shapes of standard rolled sections.

In addition to the underframe of the "Zephyr", the crankcase of the 600 hp. Winton Diesel engine powering this train is of welded Cromansil steel. The complete engine, without generator and auxiliaries, weighs only about 22 lb. per hp.

Welded Truck Parts

One of the illustrations shows a welded Cromansil truck frame, composed of 78 pieces of varying shapes and sizes, and weighing approximately 1,500 lb. as shipped with machining stock still to be removed. The flange metal in this frame is $\frac{9}{16}$ in. in thickness, and the webs in general are $\frac{5}{16}$ in. in thickness. The unique method of carrying the journal reactions into the frame proper, and the method of producing the journal-box guides from a single formed plate, are clearly shown in

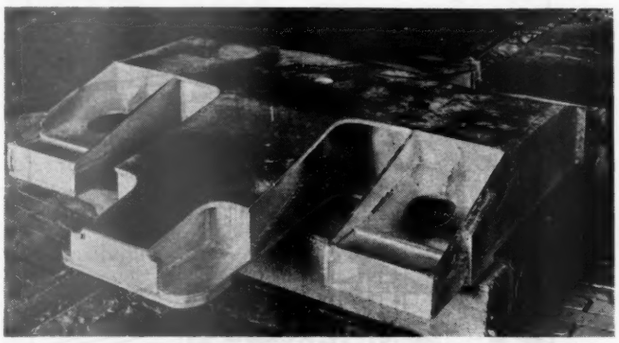


Spring plank of welded parts

an illustration. The bolster and the spring plank weighed respectively 340 lb. and 200 lb. and the ease with which the metal is placed to do the most good is quite evident from the illustrations. Parts for six truck, practically duplicates, were fabricated in welded Cromansil steel on this order for the multi-section stainless-steel car built by the E. G. Budd Manufacturing Company and now in service on the B. M. T. Lines in New York. A study of the weights of the truck frame, bolster, and spring plank indicates the desirability of such construction where

This complete truck frame, a welded Cromansil structure, was built for multi-section, stainless-steel cars for subway service

weight reduction is a paramount consideration. Another inherent feature of this method of fabrication is the fact that estimated weight schedules assume a higher degree of reliability. The final weights can be estimated with accuracy. There is no necessity for the rapping of patterns and shaving of molds to facilitate quality, with consequent overweight.



A welded truck bolster for a special service car

The use of welded-steel truck frames naturally brings to mind two questions, first, angularity with a consequent disregard for concentrations of stress, and second, a comparison with present types of built-up structural steel frames which embody all the corrosion difficulties and maintenance troubles inherent in riveted structures subject to such service requirements. As for the first question, the welded structures shown herein indicate that angularity can be minimized through proper design and efficient welding from formed steel plates. As for the second question, there are no joints in the welded-steel structures shown that permit localized corrosion or loosening of parts and subsequent weaving. The units have all the desirable attributes of one-piece structures and the added advantages of construction from a predictable material, rolled steel.

For the Sperry Rail Service's three new detector cars, the Sperry designs of truck frame, bolster and spring plank as proposed for manufacture by methods other than welding were found to be far heavier in weight than could be permitted. In addition to performing the usual functions as a truck frame, the structure carries a mass of electrical apparatus incident to the rail detection service of the Sperry cars. Here again welded-steel structures solved the problem. The frame is about 15 ft. in length and 7 ft. 6 in. in width and weighed 3,970 lb. before machining, contrasted with a minimum estimated weight of 6,000 lb. if produced by the conventional method. The frame has Cromansil steel in all primary stress members. It incorporates a double transom and special treatment at the end sills. The struts running from end sill to transom parallel to the side members were made necessary by the brake arrangement. It was impossible to apply standard clasp brakes due to the fact that the space in and around the trucks was congested with electrical equipment. A special arrangement was worked out with the reactions carried into the truck frames. Here, as in the case of the Zephyr underframes, ease in revision played an important part. It was decided during the actual fabrication of the primary members to incorporate various brake mechanism support brackets as an integral part of the frame structure. The change was made without any appreciable delay. It can be seen from the illustration that this frame, of necessity, was of such shape that it was a challenge to any process. Clearances were limited in many ways, resulting in the dips and turns in the transoms and end sills. The side frames are practically U-sections with flanges downward, reinforced on the lower edges with bars, the size of which was determined by a proper balance of the cross-section to produce maximum strength per unit area. The transom and end sills are channel shaped.

The bolsters for the Sperry detector cars are interesting from a structural standpoint. Top and bottom flanges were cut from single plates. The system of webbing is as near radial as possible. This construction permitted maximum access for welding—a paramount requirement on structures subject to such service conditions. In the rough, the bolsters weighed 950 lb. each, while the spring planks weighed 120 lb. each.

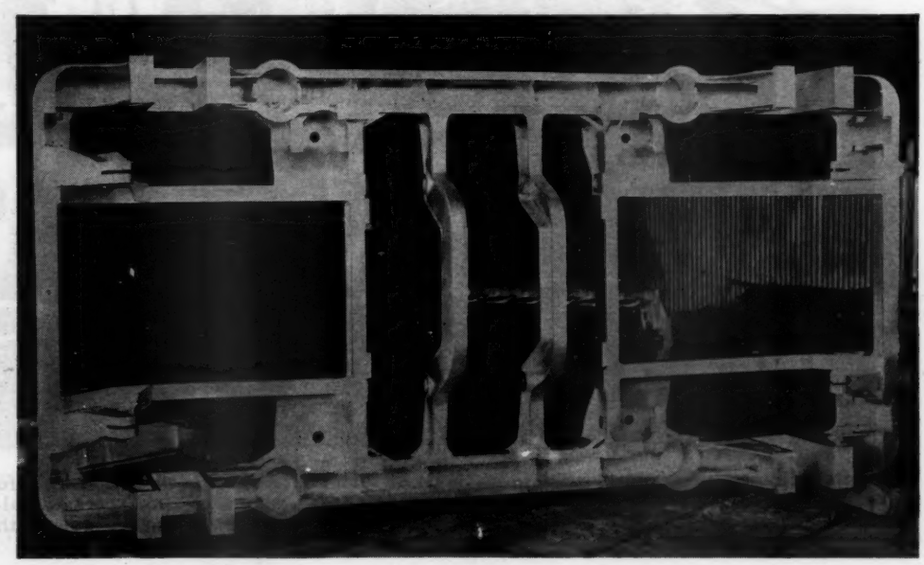
The bulk of the material used in the welded structures described herein is Lukens Steel Company's Cromansil steel, possessing the following properties:

Chemical	
Carbon	0.17 to 0.22 per cent
Chromium	0.40 to 0.60 per cent
Manganese	1.00 to 1.40 per cent
Silicon	0.60 to 0.90 per cent

Physical	
Yield point	50,000 to 60,000 lb. per sq. in.
Ultimate strength	80,000 to 90,000 lb. per sq. in.
Elongation in 2 in.	About 28 per cent

In addition, the weldability and machinability of this steel are excellent.

An important advantage of welded construction, as exemplified by the use of Cromansil steel only in the

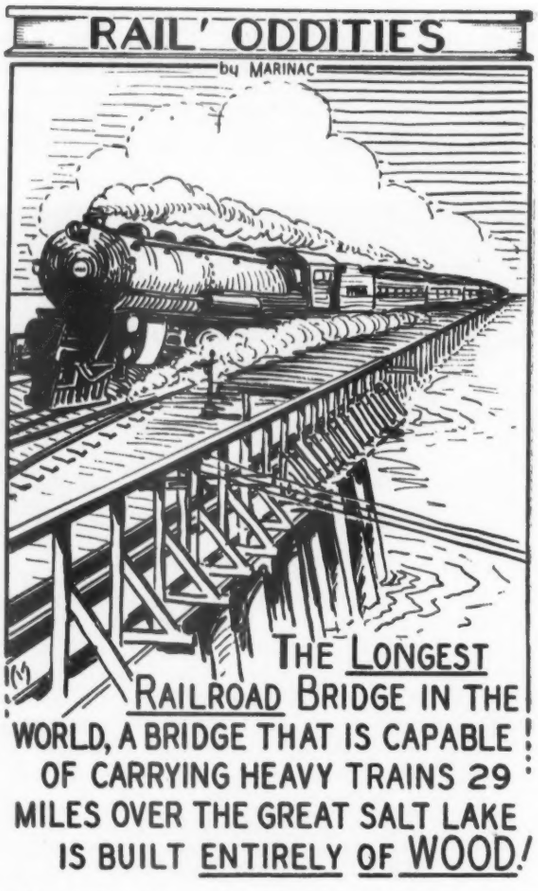


The problem of weight reduction in the Sperry detector cars was solved in the truck-frame design by the use of a welded structure, the underneath view of which is shown here

primary stress members of the Sperry car truck frames, is the ability to employ the more expensive materials discriminately throughout the structure. The journal guide plates and sundry hanger bearing pieces are usually .17 to .22 carbon welding-quality steel. This possibility presents an evident economic advantage in contrast with the necessity for complete use of an expensive alloy throughout an entire structure produced by other methods.

Considering the welded Cromansil structures described herein and their satisfactory service record to date, it is believed that welded-steel structures are finding practical and economic application in the under parts of rolling stock. Conditions surrounding the production of these welded structures were by no means economically ideal. All were special jobs. There were no precedents from which experience might have indicated the necessary procedure in fabrication. In each case, not more than a few units were involved, and all were probably produced by welding as a last resort after the possibility of casting or some other method of construction had been thoroughly investigated.

In welded steel the railroads have available a material which has been taken in the cast condition in the ingots and thoroughly hot worked in the rolling, developing physical properties superior to the usual 64,000 lb. ultimate, 32,000 lb. yield and 22 per cent elongation in 2 in. of ordinary cast steel. Coupled with this is the absence, in welded steel, of any factor limiting minimum cross-section such as a minimum size of mold interstices to permit a sufficiently rapid flow of hot metal. The railway designer has available in welded steel construction a method of fabrication that permits maximum flexibility in the creation of the design, a method that meets weight-reduction requirements and other exigencies involved by present-day trends.


RAIL' ODDITIES
by MARINAC
THE LONGEST RAILROAD BRIDGE IN THE WORLD, A BRIDGE THAT IS CAPABLE OF CARRYING HEAVY TRAINS 29 MILES OVER THE GREAT SALT LAKE IS BUILT ENTIRELY OF WOOD!

Further explanation furnished by the editor upon request

Apprentice training and up-to-date methods of instruction have not been entirely forgotten in these lean years. Here is a group of apprentices at the Palestine, Texas, shops of the International-Great Northern. Standing in the foreground are the general foreman, the superintendent of motive power, the apprentice instructor and one of the foremen.

EDITORIALS

Making Friends For Your Road

In the August number of the *Railway Mechanical Engineer* we published an interview with a public relations officer, in which he commented on ways in which the mechanical department can be helpful in making friends for the railroad.

The Tennesseean, of Nashville, Tenn., in a recent issue, told how the mechanical-department officers of the Nashville, Chattanooga & St. Louis were making friends for the railroad by throwing the shops open for inspection to school children and such organizations as the Boy Scouts. C. M. Darden, the superintendent of machinery, announced early in the fall that groups of young people, accompanied by their school teachers or Boy Scout leaders, would be welcome to visit the shops, if appointments were made in advance. It is reported that during October more than 100 young people made a tour of the shops, including the entire locomotive and car repair plant, and that there was a still larger number of visitors in November. Such courtesy pays well in making friends for a railroad or an industry under any circumstances, but all the more so for the railroads in these days, when so many children have never had a ride on a train.

An officer of an eastern railroad, amazed at his findings in this respect, recently acted as host to about 50 school children, between the ages of six and twelve, in one of the communities served by his road. They were given a ride on a train, the first experience of this sort that many of them had ever had.

It is not unusual to find railroad clubs made up of students in high schools, in districts considerably removed from railroad headquarters or division points. Sometimes the members of these clubs go long distances to visit enginehouses, shops, or other railroad facilities. A little effort on the part of the railway mechanical officers to encourage such interest in the railways by extending reasonable courtesies to the students, should prove most effective in making friends and prospective patrons for the railroads. An evidence of this is the welcome which the public has given to the high-speed, streamline, articulated trains, which have been placed on display at many railroad stations throughout the country. These trains, of course, were widely heralded and advertised and are of special interest because of their radical departure from other types of equipment.

It is interesting to note, however, that a considerable proportion of the public is interested in almost any innovation in railroad equipment, and will turn out in large numbers to see far less spectacular demonstrations than the high speed, streamline trains. This is illustrated by the experience of the Lackawanna in exhibiting a Pocono type locomotive, together with a new hopper car and a rebuilt all-steel box car at a number of passenger stations on its line. In seven cities, for instance, where the equipment was exhibited for from one to three days, it is reported that there were 125,000 visitors. An actual count revealed the fact that 61,163 persons, not satisfied with viewing the equipment from alongside, actually passed through the cab of the locomotive, in order to get a closer view of the control mechanism.

These incidents, to some, may appear to be unimportant, but looking at the problem from the standpoint of the cost to which American manufacturers go to advertise and display their products, it would seem that the railways are in a position to secure a lot of desirable publicity and cultivate many new friends, by making it possible for people in communities served by them to inspect new equipment or facilities which may be placed in service. The mechanical-department officers and employees can in this way render a real and substantial service to the welfare of the railroads which they represent.

What Life Freight Cars?

The ultimate physical life of freight cars is usually determined by the life of the center sills and the truck side and bolster castings. In the case of both box cars and open-top cars these parts will usually outlast the rest of the structure and, as cars have been built during the last few years, are good for at least thirty years—probably longer. The number of renewals of other parts of the structure will depend on the character of the service in which the cars are operated and the quality of the original construction.

The ideal physical structure would be one in which all parts were built to last for the same number of years so that the car could be scrapped at the end of its physical life without in the meantime having required any extensive renewals of parts of the structure. Improvements in the character of car construction during the past twenty years have greatly reduced the amount of light repairs required to keep cars in service as well as the frequency and amount of heavy repairs. These improvements are reflected in the reduction in the number of freight-car repair shops, in the number of freight-train accidents and in the general speeding up of the movement of freight over the railroads.

We are now entering an era in which new materials of greater strength and greater durability will be available for use in car construction. At the moment both of these qualities are receiving most attention from the

standpoint of their possible effect in permitting extensive reductions in the weight of railway rolling stock. Increased resistance to corrosion, however, may be expected to change the life history of equipment in the construction of which these materials are extensively employed. Will its ultimate physical life be greater than that of present equipment? Can the new materials be utilized to build a balanced structure which can be scrapped when extensive renewals become necessary?

Physical factors, of course, do not operate alone in determining the useful life of a freight car. The ever-present but intangible obsolescence is of at least equal importance. Obsolescence is the effect of change on the relative value of physical things. In the case of cars the changes are of two kinds. One is improvements in car construction which may reduce the cost of maintenance, increase the reliability of the car in train operation or improve the service to the patron by better protection of lading, by meeting his ideas as to shipment size, etc. The other is changes in the shippers' ideas with respect to packaging, unit size of shipments, etc., as well as shifts in the character of traffic on a given railroad which operate to reduce the utility of certain types of cars.

Such factors are of as great importance in determining the actual useful life of freight cars as those which fix their ultimate physical life. While the exact character of the changes which cause obsolescence can never be foreseen, that they will continue to take place should never be held in doubt. Allowance should be made for that fact in determining what physical life shall be built into new freight cars, so far as this can be controlled by the designer. Shall the car be built to last the life of its most durable portions—at least thirty years—or shall it be built so that at the end of, say, twenty years the usable material left in it will not be sufficient to make its retirement uneconomical? With the changing conditions as to traffic and business relations, and with the assurance of continued technical progress, it is not economy to build for long physical life.

Freight-Car Conditions in 1935

An interesting preview of probable freight-car conditions in 1935, particularly as relates to repairs and retirements, is afforded in a statement on this subject recently issued by the Federal Co-ordinator of Transportation. This statement, prepared by the Section of Car Pooling, summarizes the replies to a questionnaire sent to all Class I railways and not only presents a picture of actual freight-car conditions as of July 1, 1934, but shows what the railways plan to do in the way of repairs and retirements during the succeeding 18 months, or up to December 31, 1935. The announced object of the co-ordinator in issuing the statement was to direct attention to the condition of freight cars, following a long period of light demand, and to promote the early retirement of those cars which have outlived their period of effective service life and are obsolete or excessively costly to maintain.

No attempt is made in the summarized replies to the questionnaire to cover such items as car age, load limit, ledger value and depreciation, the report being devoted exclusively to retirements and repairs. According to the figures presented, Class I railways retired, in the year ending June 30, 1934, 51,151 box and automobile cars, 20,690 gondolas, and 12,626 hopper cars, which, with other types retired, made a total of 98,132 cars. This constituted 4.8 per cent of the ownership as of July 1, 1933. While the exact figures are not available, the railways expected to retire 68,151 cars in the last half of 1934, and 96,144 cars are scheduled for retirement during the year 1935. This rather extensive retirement program is made possible by the action of the Interstate Commerce Commission last June in approving applications from individual railways for authority to charge retirements to the profit and loss account. The extent to which actual retirements in 1935 meet the estimate will be contingent to a large extent upon railway traffic and earnings, which also is, of course, a vital factor in expenditures for maintenance.

According to the report, Class I railways planned to give general repairs to 64,494 cars at an aggregate cost of $19,827,839, or an average of $307 per car, in the last half of 1934. For the year 1935, it is planned to give general repairs to 223,788 cars, at an average cost of $65,699,111, or an average of $294 per car. Eliminating the cars to be retired through 1934 and 1935, the above repair program is equivalent to giving heavy repairs to 15.8 per cent of all cars and 16.2 per cent of the box cars left from the July 1, 1934, inventory.

The statement also provides an estimate of the number of cars to be given additions and betterments during the last six months of 1934 and the year 1935. The number of cars affected is 88,991 and the total cost $18,399,450, or an average cost of $207 per car. Unquestionably, a sizable amount of this expenditure will be devoted to the replacement of arch-bar trucks which are still in service on practically one-third of the freight-car ownership. An examination of figures compiled by the Association of American Railways, Mechanical Division, indicates that the percentage of freight cars, both railroad and privately owned, equipped with arch-bar trucks, was 44.2 per cent on January 1, 1930; 40.8 per cent on January 1, 1931; 38.7 per cent on January 1, 1932; 37.4 per cent on January 1, 1933; 35.4 per cent on January 1, 1934; and 34.1 per cent on June 30, 1934. Present indications are that the effective date of January 1, 1936, when cars equipped with arch-bar trucks will be non-acceptable in interchange, must be extended, but it is much to be hoped that this extension will not be used as an excuse to minimize the importance of scrapping

aged cars equipped with arch-bar trucks and replacing arch-bar trucks with modern cast-steel side frame trucks just as fast as it is physically and financially practicable.

Streamlining

Streamlining, in its introduction on American railroads was associated with reductions in cross-section and light weight in the design of articulated train units in order that high speeds might be attained without the need of power-plant capacity in excess of what could be readily applied in a self-propelled unit. The effect of weight reduction is better understood than either of the other two factors, both of which affect air resistance.

Professor Klemin, in his series of articles which appeared in the August, September and October issues of the *Railway Mechanical Engineer,* concludes that the air resistance of the steam locomotive in its conventional form is a great waster of power and that this situation can be greatly improved by the application of a simple cowling without any change in the structural features or general arrangement of the design. The wind-tunnel tests at the National Research Laboratories of Canada indicated a reduction in air resistance of the locomotive of 35 per cent by the application of cowling over the top of the boiler and at the front end to provide a smooth air flow and a clean-cut lifting of the smoke above the top of the locomotive. The New York Central, which in its "Commodore Vanderbilt" has gone somewhat further than was done in the models tested in Canada, particularly in completing the cowling over the top of the tender, anticipates about 36 per cent reduction in the air resistance of the locomotive, on the basis of its own wind-tunnel tests conducted at the Case School of Applied Science, Cleveland, Ohio.

Turbulence along the sides of the train and resistance to side winds can be reduced by smoothing up the surfaces, by applying inward curving skirting below the sides of the underframe and by replacing the customary monitor type roof with a smooth roof of the turtle-back type. Straight, longitudinal roof lines at the ends of the coaches, somewhat after the British manner, may be expected to reduce turbulence between coaches, which it would seem is induced by the downward curving ends customary on American equipment. In this connection it is interesting to recall the fact that the Canadian tests indicated that the presence or absence of side and roof curtains to close the gap between the locomotive cab and the front of the tender made no difference in the air resistance of the model.

The intimate association of streamlining with weight and cross-sectional reductions has aroused interest in the relative value for reducing train resistance of these factors considered separately. The unique method of analysis developed by G. I. Wright and P. A. McGee in their paper before the New York Railroad Club, the second and concluding installment of which appears in this issue of the *Railway Mechanical Engineer,* provides a means for an evaluation of this kind While their method of calculating head-end and rear-end air resistance separately from the so-called skin friction and eddy losses along the sides of the train needs the confirmation of further experimental work, it is believed to represent a fair approximately to actual conditions.

One of the first things indicated by an application of this method of analysis is the decreasing importance of head- and rear-end air resistance in relation to total air resistance as the length of train increases. In a train of six Pullman cars, or their equivalent in length, head-end air resistance amounts to over 40 per cent of the total air resistance, whereas in a train of 14 cars of the same kind it represents about one-fourth of the total air resistance. At 100 m.p.h. air resistance becomes over 57 per cent of the total resistance in the six-car train and about 48 per cent of the total in the 14-car train. Approximately the same proportions apply in the case of trains of similar length, but of reduced cross-sections. This indicates the relative importance of attention to the exterior surfaces of passenger cars intended to run in long heavy trains as compared with changes in end formation, and suggests that attention to such details are of importance where high speeds are to be attained.

The effect of weight reduction on train resistance is well defined at all speeds, being proportionately greater, of course, at the lower speeds where frictional resistances form a relatively large part of total resistance. On the other hand, special end streamlining, while of relatively little importance below, say, 60 m.p.h., grows rapidly in importance as the speed increases.

Assuming a 30 per cent reduction in weight with no other change, this will cause a reduction of 12 per cent in resistance at 60 m.p.h. and about 7½ per cent at 100 m.p.h. in the case of the 14-car train. In the case of the six-car train the effect of such a weight reduction will be about equal to that of the streamlining of the ends at 60 m.p.h.,—8 per cent—but at 100 m.p.h. will represent only about a 5 per cent reduction, whereas the special end formation would probably effect a reduction of resistance of 12 per cent. A reduction in cross-section of the lighter weight train from 120 sq. ft. to 100 sq. ft. would effect a 5 per cent reduction at 60 m.p.h. and something more than 12 per cent at 100 m.p.h. as compared with the lighter weight cars of full cross-section. The effect of a similar change in resistance of a train of six cars would be to reduce total resistance by about 9 per cent at 60 m.p.h. and 11 per cent at 100 m.p.h.

These comparisons give some indication of the relative value of the different factors as applied to long and short trains. A further reduction in the length of the train would rapidly increase the proportionate effect of end formation on total air resistance as well as on total train resistance. The reduced cross-section, because of its reduction of the longitudinal surfaces of the train, tends to increase its proportionate effect on total resistance as the length of the train increases.

With the Car Foremen and Inspectors

Reducing the Cost Of Heating Rivets

RECOGNIZING the savings possible by using low-pressure instead of compressed air for operating burners and air curtains on oil-fired rivet heaters, the Illinois Central system recently installed 44 low-pressure units at Centralia (Ill.), Nonconnah (Tenn.), McComb (Miss.), and Vicksburg (Miss.) shops.

To the casual observer, or even the experienced shop man, a small rivet heater, burning only a few gallons of oil an hour, seems scarcely to offer the opportunities for saving that really exist. Considering, however, that, even at very nominal power rates, it costs $100 during an average working year for only the power used to compress to 80 lb. the air discharged through a hole that can be plugged by the lead of an ordinary pencil, it begins to be evident how important it is to give careful consideration to the use of compressed air, and substitute a less expensive medium whenever it is practical to do so.

For certain purposes compressed air is indispensable and economical, such as for riveting, chipping, sand blasting, etc., but for rivet heating, it can in many cases be replaced to advantage with low-pressure fan or blower air.

This does not mean that there is no longer any place for the small portable-type rivet heater that operates with compressed air. Such equipment should be used for heating small quantities of rivets for light repairs, for emergency work or for jobs that require that the heater be frequently moved from one location to another. For such work the small portable-type heater has a practical advantage over the low-pressure type, even though the air cost is much higher.

In connection with car manufacturing and rebuilding programs which require large quantities of rivets of various sizes, and when it is customary to move the work to the heater instead of moving the heater to the work, there is a real opportunity for saving in the cost of air required for operation of burners and air curtains. It is not unusual to find that compressors are overloaded and that consideration is being given to increasing compressor capacity by the installation of another unit. A careful check of the requirements of equipment, such as rivet heaters, will often reveal that if this equipment were taken off the compressed-air line, there would be ample air for the equipment that must be operated with compressed air.

In the operation of oil-fired rivet heaters, air is required for two purposes. One is to operate the burner and the other to provide comfortable working conditions for the operator. For the latter purpose, it is common practice to install an air curtain pipe in front of the heater opening. Seldom is the cost of operating the air curtain given serious consideration, even though there is more opportunity for saving at the curtain than at the burner.

For quick approximation of the saving that can be made during an average working year, it will be found convenient to refer to the table which shows the savings separately for both burners and air curtains.

The accompanying photograph shows a line of these new low-pressure rivet heaters at Centralia shops. The drawing shows details of the construction, including the arrangement of the fire brick lining and the application of blower, burner and air curtain pipes. These heaters were constructed in the shops of the Illinois Central. Burner and blower equipment was furnished by Mahr Manufacturing Company.

Fuel oil is supplied from a 2-in. pipe run underground from the fuel-oil tank to the heaters. Oil-line pressure is kept constant at 25 lb. Directly below the burner of each heater, the underground supply pipe is fitted with a tee for making connection to a Mahr safety automatic shut-off valve. From this valve, a ½-in. pipe is run to the strainer and oil regulating valve of the burner and connection made from the regulating valve to the burner.

Savings Per Year of 300 Ten-Hour Days by Substituting Low-Pressure Fan-Blast Air for High-Pressure Compressed Air in Oil-Fired Rivet Heaters

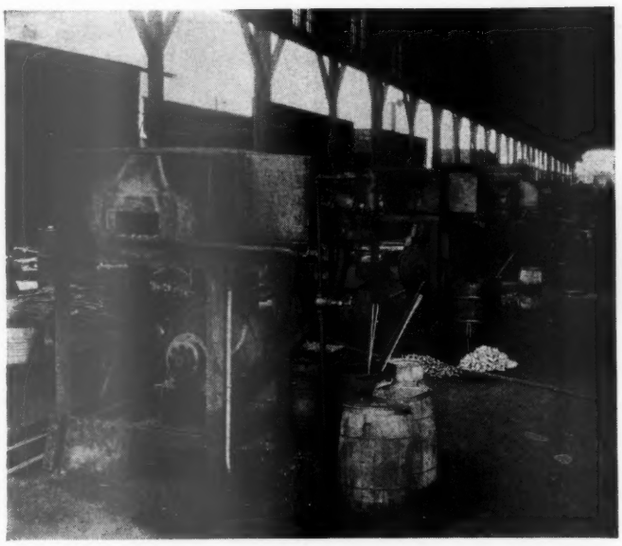
OIL BURNERS ONLY

Oil burned per hour, gallon	Cost per power per kilowatt-hour, cents ½	¾	1	1¼	1½	1¾	2	2¼	2½
1	$ 5.87	$ 8.80	$ 11.73	$ 14.66	$ 17.59	$ 20.53	$ 23.46	$ 26.39	$ 29.33
2	11.73	17.60	23.46	29.33	35.19	41.06	46.92	52.79	58.65
3	17.60	26.40	35.19	44.00	52.79	61.59	70.38	79.19	87.96
4	23.46	35.19	46.92	58.65	70.38	82.11	93.84	105.57	117.29
5	29.33	43.99	58.65	73.32	87.98	102.64	117.30	131.97	146.63
10	58.65	87.98	117.30	146.63	175.95	205.28	234.60	263.93	293.25
50	293.25	439.88	586.50	733.13	879.77	1,026.38	1,173.00	1,319.63	1,466.25
1 00	586.50	879.75	1,173.00	1,466.25	1,759.50	2,052.75	2,346.00	2,639.25	2,932.50
3 00	1,759.50	2,639.30	3,519.00	4,398.80	5,278.50	6,158.30	7,038.00	7,917.75	8,797.50

AIR CURTAINS ONLY*

Air curtain pipe-length ft.	½	¾	1	1¼	1½	1¾	2	2¼	2½
1	157.15	235.72	314.30	392.87	471.44	550.02	628.59	707.16	785.74
2	314.30	471.44	628.59	785.74	942.88	1,100.03	1,257.18	1,414.33	1,571.47
3	471.44	707.16	942.89	1,178.60	1,414.33	1,650.05	1,885.77	2,121.49	2,357.21
4	628.59	942.89	1,257.18	1,571.47	1,885.77	2,200.06	2,514.36	2,828.65	3,142.95
5	785.74	1,178.61	1,571.47	1,964.34	2,357.21	2,750.08	3,142.95	3.535.82	3,928.69
10	1,571.47	2,357.21	3,142.95	3,928.69	4,714.92	5,500.16	6,285.90	7,071.64	7,857.37
50	7,857.36	11,786.05	15,714.73	19,643.42	23,572.10	27,500.80	31,429.50	35,358.19	39,286.85

*Note that the comparison is based on using compressed air at 80 lb. through 3-64-in. holes, spaced on ½-in. centers, and fan blast air at 10 ounces through ¼-in. holes, spaced on 1-in. centers, which is common practice for effective protection to operators.



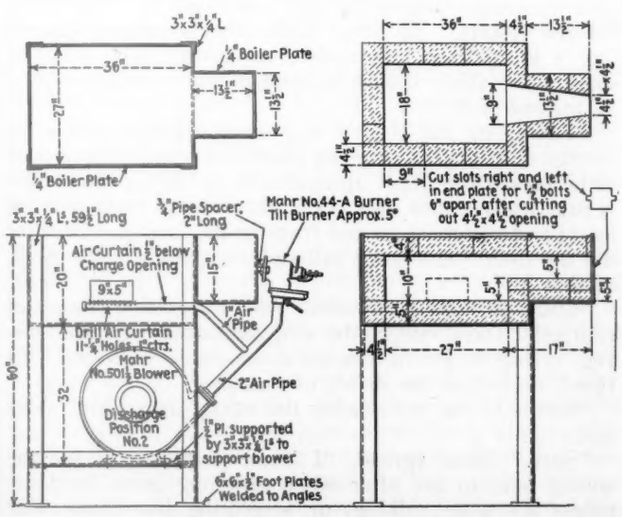
A battery of low-pressure rivet heaters installed at Centralia shops

The safety shut-off valve was installed automatically to shut off the flow of oil to the burner if anything caused the oil pipe to break.

A special feature in the construction of the heater is the extended combustion chamber which serves to premix the fuel and air so that combustion is complete when the products enter the heater chamber. The burner is tilted approximately 5 deg. from the horizontal so as to have the flame strike the arch above the center of the heater opening and cause rotation of the flame. The combination of extended combustion chamber and tilting of the burner permits complete mixing of the gasses and makes it possible to maintain a soft non-scaling atmosphere which is particularly necessary in heating rivets.

The rivet heaters are set at right angles to the repair track and two crews work from each heater. A quantity of from three to five sizes of rivets are kept hot so that the riveters are never obliged to wait for hot rivets. The operator working from one opening in the heater does not interfere in any way with the operator working from the other opening as they are on opposite sides of the heater.

The hearth heating area measures 18 in. by 27 in. which allows each operator a space of 9 in. by 27 in. for heating the rivets his crew requires. This space is ample for heating all the rivets of various sizes that one crew will require.


Boiler Plate
Mahr No.44-A Burner Tilt Burner Approx. 5°
Pipe Spacer 2" Long
Air Curtain 1" below Charge Opening
Drill Air Curtain 11-⅛ Holes
Mahr No.50½ Blower
Discharge Position No.2
1" Air Pipe
2" Air Pipe
Cut slots right and left in end plate for ⅞ bolts 6" apart after cutting out 4½ x 4½ opening
Foot Plates Welded to Angles

Application of Mahr burner and blower to low-pressure rivet forge on the Illinois Central system

The heater consumes approximately three gallons of oil per hour and is fitted with an air-curtain pipe 9 in. long at each opening for the comfort and protection of the operators. A 1½-hp. blower supplies the air required for both the burner and the air-curtain pipes.

The cost of compressed air varies somewhat, depending upon the type of compressor used and the cost of the power. Taking into consideration both steam and motor-driven compressors, the average cost of compressed air on the I. C. is $.0679 per 1,000 cu. ft. of free air compressed to 100 lb. pressure. Assuming average compressor efficiency, this cost is equivalent to a power cost of approximately $.025 per kw. h. when using the table to determine savings per year when low pressure instead of compressed air is used for burners and air curtains. Using the table to determine the savings per year as the result of installing 44 low-pressure instead of compressed-air-type rivet heaters at various shops on the I. C., it is observed that this amounts to: Burner (3 gal. per hr.), $87.96; air curtain (1½ ft.), $1,178.61; total per rivet heater per year, $1,266.57; grand total, 44 heaters, $55,729.08.

The actual power saving is only one of the economies and advantages resulting from the use of low-pressure instead of high-pressure oil-burning equipment.

Experience has shown that fire-brick linings last considerably longer. In one instance, a heater of the high-pressure type required new lining every five months. When changed over to low pressure, lining life was increased to eight months. The low-pressure blast actually submits the steel to a soft soaking heat conducive to thorough and uniform penetration and takes the "bone" out of the steel to such an extent that fewer blows are required for working it to the desired shape.

Cleaning Oil Drums

THE illustration shows at *A* a steaming platform successfully used at the Chicago shops of the Chicago & North Western for cleaning oil drums or barrels which have contained heavy oils. This platform consists of a suitably supported and inclined sheet-metal drain pan, above which two small timber joists are bolted the required distance apart to serve as a support for the oil drums, which stand on end. Five drums can be cleaned at one time on this device, steam being supplied from five vertical pipe jets which extend upward from suitable pipe connections near the center line of the oil drain pan and are so spaced as to accommodate oil drums of the usual size.

In operation, the two plugs usually provided in each oil-drum top are removed, the drums being inverted and placed on the steaming rack with the steam nozzles extending up into the drums. Steam pressure is turned on for a period of about 10 min., during which the interiors of the drums are thoroughly heated, the oil and condensed steam drained out through the open plug holes and the drums thoroughly cleaned. Drums containing lighter oil are placed one at a time on a special tumbling rack, shown at *B*, which supports the drum horizontally.

Cleaning oil drums by the steaming method at the Chicago shops of the Chicago & North Western

Steam is applied through a long nozzle, after which the drum is placed on end and any residual moisture extracted by an air syphon is shown at *C*.

Dave Pays for a Transferred Load

By T. J. Lewis

A GREAT many car inspectors seem to think that they can avoid trouble for themselves and expense to the company they work for by keeping foreign cars off their road as much as possible. With this idea in the back of their heads they begin to make a practice of applying a "B. O. Return When Empty" card to every switch car given them by connecting lines, if they can find any defect on it whatever. It is a wrong idea, of course, and a faulty practice, and like all such, it brings its penalty sooner or later, usually sooner.

It is easily seen how this idea becomes imbedded in an inspector's mind, for he has experienced himself, or he has intimate knowledge of some other inspector having experienced the misfortune of receiving a foreign car on his road and then having it develop a serious defect before it leaves the line. Maybe it shows up at the other end of the road under load, in a condition that requires the load to be transferred. Then, it seems to the inspector involved that he is the only man in the world that does not firmly believe that the defect existed when he received the car on his line, unless the damage is of such a nature that it is plain that he could not have overlooked it, or unless there is positive knowledge as to how and when it occurred.

One result of this practice is that it often prevents the use of a car for return loading when there is really no good reason why it should not be so used and when it is needed. This causes inconvenience and extra switching time and expense to the transportation department. Often in a case of this kind the yardmaster or switch-foreman will get together with the inspector and when the inspector learns that the car is really needed he will remove his B. O. card and allow the car to be loaded. This soon produces a lack of respect for the inspector's cards and that, in turn, opens up the way for several sorts of trouble.

Dave had drifted into this habit and Alec had often tried to talk him out of it, but his efforts had never produced anything but an argument and the mere fact that Alec condemned Dave's practice served the purpose of convincing Dave more firmly that he must be right. So a few days ago Dave "ketched a b'ar by the tail."

ALEC hadn't been long in his office when, on looking through the window he saw Dave coming across the yard. He could tell by Dave's hurried, determined step that whatever the matter in hand was Dave considered it very important. He didn't have long to wait. Dave blustered in like a gust of hot air laden with coal smoke, with his usual, "Hullo, Alec," proceeded to seat himself on an empty nail-keg at the corner of Alec's desk.

"What you got on your mind, Ol' Man? Blank, as usual?" Alec asked.

"'Bout as usual, I guess. Same old things over and over with just a little variation occasionally, like this one I've got in my pocket," Dave said, as he drew his book from his pocket, took a transfer authority card out and laid it over in front of Alec on the desk. "All I need is your 'John-Henry' on that dotted line and everything'll be pretty."

Alec picked up the card, looked at it a minute and laid it down, saying, "Well, Dave, if I'd sign a paper for anybody I would for you, but that's one bad habit I've quit. Took me a long time to break myself of it, but finally I succeeded and now I've almost forgot how to spell my name, much less write it. Yes, sir, just can manage to scribble it on my pay-check."

"Oh, well," Dave said, "You needn't get so ignorant all of a sudden. I never did think you was the fellow folks referred to when they said 'Smart Alec,' but just do the best you can on that and I'll make out with it."

"Can't do it, Dave," Alec shook his head.

"Yes, you can," Dave continued, good-naturedly, "I'll give you what prompting you need and be responsible for the results. To begin with, there's not any k, nor any z in spelling 'Alexander,' no matter how much it sounds like there should be, and it starts with a capital A, instead of E."

"Taking up Ed Hunt's way of trying to transfer all foreign cars just to save per diem, are you?" Alec asked as he picked the ticket up again, then, "Why, Dave, this is practically a new car; better than any of your own, at least; and you must go and transfer the load just because the car didn't have your railroad company's name on it. Is that it?"

"Oh, just wait a minute. You are getting ahead of yourself," Dave said, as he wriggled around on the nail-keg, trying to get in a more comfortable position. "Ed Hunt, himself, is the daddy of that job."

"Seems to me you're after the wrong man then," Alec said.

"Sure," Dave agreed, "I know you are always the wrong man to get after when anything is to be done, unless it's some talking, or something like that. But what I'm in need of now is your signature on that transfer authority card, and just talking won't do."

"Where did this car come from to begin with?" Alec asked.

"You folks gave it to us two days ago," Dave explained, "and when we got it it was tagged to The Falkner Lumber Company, but they reshipped it in the same car to Lawley, forty miles out on the G.Y.M. That's how Ed got a shot at it. Wasn't much of a defect; draft channels cracked through the front draft keyway, caused by a slack draft gear allowing the draft-key to engage the center channels."

"I saw that crack when the car came in," said Alec, "but it was not bad enough to think about transferring the load for. Still, that's yours and Ed's goose; you can cook it to suit yourselves, but just count me out."

"Oh, yes, that sort of talk sounds as pleasant to you as the knocking-off whistle, but the car came from you, and you are due to pay for transferring," Dave persisted.

"Nothing doing," Alec said with a finality that caused Dave to realize that he had a job before him, but Dave being no quitter, rearranged himself on the nail-keg and buckled into the job with:

"Now, look here, Alec, there's not a bit of use in you starting any of your foolishness. It's like this: you folks brought the car in here and got pay for hauling the load. You gave it to us and we took it out to the lumber yard and from there to the G. Y. M. and they get pay for hauling it from here to Lawley. What do we get? We get a measley switching charge and have to pay for transferring the load because you folks brought it here in a crippled car. We won't do any such business as that."

"Already done it, haven't you?" Alec asked.

"Yes, I gave Ed a transfer authority and there is my rebuttal ready for you to sign," Dave replied.

"You should have let the Falkner Lumber Company transfer the load while it was in their yard," Alec suggested.

"Why, of course, Alec," Dave said, fretfully, "I and everybody else should have done just exactly different from what we did do and that would leave not a thing for you to do, if I get your idea right."

"No use to get huffy about it, Dave," Alec said quietly, "you know yourself if you wanted us to pay for transferring the load you should have put a transfer card on it when you received it."

"The devil!" Dave snorted, "I had no notion the blamed thing was going anywhere but to the lumber yard, so I just put a 'B.O. Return When Empty' card on it and let it go at that."

"Oh! You did, huh," Alec said, disgustedly, "and no doubt the car was delivered to the G. Y. M. with that card on it."

"What difference does it make?" Dave asked. "Ed could see for himself that the sills were broken."

"Only slightly cracked," Alec corrected, and continued, "Besides, if it hadn't been for your card Ed would have concluded that we both ignored the defect and would have paid no attention to it himself."

DAVE was getting in a tight place. He realized that his own company's switchmen were not paying any attention to his B.O. card and delivering the car to a connecting line with the card still on it was almost surely the cause of Ed Hunt refusing to run it. However, he had to put the best face on the case that he possibly could and if possible, get Alec to sign his transfer authority card, for it gave him an extremely disagreeable feeling in the middle of his stomach and caused his nail-keg seat to be very uncomfortable to think of his railroad company having to pay for transferring a load on nothing but a switch movement. He was anxious to let himself down as lightly as possible, so he said:

"Can't tell about that, Alec; you see, Ed was on the receiving end of the job and if he didn't like the idea of running a car in that condition there was nothing to prevent him from turning it down."

"Certainly not," Alec stormed, "and that blamed card of yours was a cordial invitation to turn it down. Ed is no fool and right away he saw the opportunity to transfer the load into one of his own cars at your expense, save per diem and block any argument you could make with your own bad order card."

As Dave's hopes sank, his temper rose. He felt that he was about to be done wrong and he had no notion of submitting meekly.

"That's the rottenest trick I've ever known of, Alec," he said. "Bring a load in here in a crippled car and then refuse to pay for it being transferred."

"I'll tell you what you do," Alec suggested. "Go to see the lumber people and explain the situation to them and maybe you can persuade them to pay for the transfer of the load."

"Done been," Dave growled.

"What did they say?" Alec asked.

"Just as nice as pie and as mean as sin," Dave replied. "They were very sorry if the railroad company was inconvenienced in any way, but they had sold the load of lumber to a man in Lawley even before it arrived here, so, all they had to do was to rebill it and give the switching order to the railroad yard office and they were through with it; just waiting now for the buyer's check, in payment for it. Meantime, a copy of the bill of lading is in their desk and everything is pretty with them. No, they couldn't think of paying for the transfer of the load from one car to the other. That was the railroad's business, if they wanted it done. Altogether, they were just as mean and stubborn about it as you are, but in a nicer way, they being nicer folks than you." Dave concluded.

"Sure. Nicer folks," Alec admitted, "but do you suppose your own manners could have anything to do with the difference in them and me?"

"O, damn all that," Dave grumbled, "Nobody could get along with you without cussing you out every few days. But what I want to know is whether you are going to sign that card or not."

"No! Sure not," Alec said with a finality that left no room for doubt. "Id be glad to help you out, but in this case there is nothing I can do."

"Alright then," Dave concluded, "I'll just take the whole thing to the Old Man and explain it to him and I'll bet he will get a transfer authority signed. I hate to bother him with it, but when people act as contrary as you and the lumber company folks, there's nothing else I can do."

"I wouldn't do that, Dave, if I were you," Alec advised.

"I know you wouldn't do a thing. Nobody'd expect you to," Dave stormed, "But you know as well as I do that it's not right for us to have to pay for that transfer when we get no haul out of the load."

"Well," said Alec, "you do as you please about taking the matter up with the Old Man, but if it was me, I'd let it pass as quietly as possible and hope that he wouldn't get onto it at all, because it can't be helped now, and if you get him to digging into it, it'll only prove that you put that card on the car, without sufficient cause and then smugly sat down in your own corn-patch and let the lumber company and Ed Hunt out-smart you for the cost of transferring that load of lumber. No, sir, I'd just wait for him to find it out and be hoping all the time he didn't. Of course, I'm sorry. . ."

"I'll say you are," Dave snorted as he arose, reached over for the card that Alec had refused to sign, viciously kicked over the nail-keg that he had been sitting on under the table and strode out of the office.

Swivel Head Bolt Cutter

A BOLT cutter with a rigid head has been a familiar and exceedingly useful tool for many years. There are, however, frequently places which this tool cannot conveniently reach. By an ingenious, yet simple, arrangement the manufacturer—H. K. Porter, Inc., Everett, Mass.—has converted this tool into one that can be used equally well in practically any position. As indicated in the illustration the swiveled cutter head may be turned to any angle on either side of the handles from direct up to a right angle. A special section, joined by

Porter universal bolt cutter with swivel head—Light portions indicate some of the positions for the head

a ball-and-socket joint, with a shoe for holding the cutter head and a positioning spring to retain the head in the selected position are all the changes required. Any standard head may be used—clipper cut, center cut, chain cutter, nut splitter, etc.—and changes from one head to another may be quickly made. Standard Porter bolt cutters may be converted into swivel type at small expense.

Mechanical Maintenance of Air Conditioning Equipment

By H. K. Allen

THE rapidity with which air-conditioning equipment came into use found the regular force of passenger-car maintainers unprepared successfully to maintain the various types of equipment during the first season of service and resulted in numerous failures. However, all of these failures could not be attributed to unpreparedness. Many were caused by weaknesses in design and in most cases were on experimental equipment.

The second season of air-conditioning service not only found the maintenance department prepared with a force of carefully selected and well trained men, but found them equipped with proper repair-shop equipment and sufficient tools to make the necessary adjustments and repairs to the complicated apparatus used in connection with the air-conditioning equipment.

Improvements in the design, simplicity of operation and standardization of equipment has effected a more economical maintenance of this equipment and has resulted in a substantial reduction in the number of failures during the past few months.

The operation of air-conditioning equipment is controlled entirely from a control panel usually located adjacent to the electric lighting locker. These panels are properly marked to indicate the normal position of the switch blades to secure the battery or the generator voltage. The stop and start buttons controlling the compressor and the circulating fans are also marked so that the operation of the equipment is more or less foolproof. Other than an occasional renewal of an indicator light bulb there is no maintenance necessary as far as the panel board is concerned.

Mechanical Inspection

Careful inspection of air-conditioning units is essential if satisfactory results are to be expected. The frequency of these inspections depends entirely on the amount of service that is performed by each unit. While it should not be necessary to inspect, clean and adjust all parts of the equipment daily or even weekly, it should receive an inspection after each trip to determine that all parts are functioning properly. In addition to the trip inspection a subsequent inspection should be made each 15 days and another each 30 days. These later inspections should include cleaning, adjustments and lubrication.

The trip inspection should determine that the unit is providing an even and comfortable temperature inside of the car without requiring the attention of the porter to operate the system intermittently from the control panel. If the compressor stops before the temperature of the car reaches the level set on the thermostat it indicates low battery voltage, a blown fuse or a faulty contact in either the thermostatic control or to the compressor motor. This must be run down and corrected before attempting further tests.

All piping should be checked for leakage while the equipment is operating by the use of soap suds. Float valves should be examined to see that the proper water level is maintained in the cooling tower and the screens should be cleaned if found to be dirty.

High and low pressure refrigerant gages must receive a careful inspection to determine whether or not additional refrigerant is required. Where it is necessary to add refrigerant a minute inspection should be made of the tubing to see that it has not broken loose at sweated joints or opened up in seams causing a waste of the liquid. The refrigerant Freon used in many of the present types of air-conditioning systems costs about 75 cents a pound and usually does not deteriorate so that when losses in pressure are detected, if not promptly checked and the cause corrected, they may result in an excessive operating cost per unit.

Where the line is found frosted at the evaporator an examination should be made of the expansion valve as the valve is in need of adjustment and is permitting too much Freon to enter the evaporation coil. An exception to the above example will occur if the temperature on the inside of the car is somewhat lower than that where the compressor is located. A case is recalled where a pre-cooling unit was used to bring the inside temperature of the car down to about 75 deg. before starting the air-conditioning equipment. The outside temperature was between 95 and 100 deg. When the circulating fans carried the cool air from the car's interior through the recirculated air grille it caused the pipes and the evaporator as well as the compressor to frost.

Water pressure gages should be checked to see that they register from 7 to 14 lb. when operating on storage batteries and not to exceed 20 lb. when operating on the generator. Should the pressure exceed 20 lb. it indicates

that the spray nozzles in the cooling tower are dirty and require removal and cleaning.

If the compressor valves are causing excessive noise it indicates air in the system. This can be further determined by observing the reading on the high-pressure gage which should not indicate a pressure in excess of 150 lb. Where the pressure is greater than 150 lb. it is necessary to purge the system several times. A vacuum pump should be available for this purpose.

During this inspection the spring tension on generators should be adjusted where an examination discloses slack in the flat or the V-type belts. All bolts must be tested in the suspension and drive-shaft couplings.

In addition to the trip or daily inspection the following attention should be given to the air-conditioning system each 15 days:

(1) Cars equipped with the water-cooled condensers should have the cooling tower thoroughly cleaned by removal of the overflow connection as well as the water strainers and the spray nozzles. Flushing the cooling tower with cold water under ordinary city pressure will usually clean it satisfactorily. All piping leading to the cooling towers from the compressor should be flushed by allowing city water pressure to pass through the lines.

(2) The tubing in the air-cooled type of condenser can also be cleaned with water pressure. However, the compressor should be dried after cleaning. The spray nozzles can be removed and blown out with compressed air to assure the stem being clean.

(3) The oil level of the compressor crankcase must be observed to assure that sufficient oil is shown on the gage to register at a point between the low and maximum level marking. Should it be necessary to replenish the oil supply, only an approved grade of compressor oil should be applied to prevent damage to the compressor or obstruction in the lines.

The trip or semi-monthly inspection should assure a satisfactory operation of the air-conditioning equipment with a minimum of maintenance work being required and which should not make it necessary to hold the car off the run or otherwise interfere with its normal schedule. However, a monthly inspection should be made at which time a thorough reconditioning of the equipment, including complete lubrication should be made. While the items above referred to in the daily and semi-monthly inspection should receive the monthly inspection the following servicing is important:

(a) Change oil in compressor crankcase.

(b) Refill all grease cups in compressor, condenser, fan and cooling-tower motors, giving them sufficient turns after refilling to indicate lubrication at packing nuts.

(c) Repack grease glands on all water pumps, renewing the packing where found deteriorated.

(d) Lubricate all generator armature bearings, being careful that excess oil is not used.

(e) Oil or grease all parts of generator drive shaft.

In addition to the flushing of condenser coils in the cooling towers they should be scraped or brushed before flushing during the monthly inspection period in order to remove all pitting and scale from the tubes.

The automatic expansion valve located in the dry coil unit should not require adjustment as these valves are usually sealed upon application, however they should be carefully checked to see that they are not clogged. Where there appears to be an obstruction the valve can be cleaned by closing the receiver valve and operating the compressor until sufficient vacuum shows on the low pressure gage then by closing the valve leading from the compressor to the cooling condenser and stopping the compressor the bonnet can be removed from the body of the expansion valve. After cleaning and replacing the bonnet the receiver valve should be opened and the compressor operated for several minutes to clear the air from the lines.

Electrical Equipment

The electrical equipment, which constitutes a major portion of the air-conditioning unit, must be carefully inspected and adjusted by competent men. Batteries must be flushed and the maximum water level maintained. Generators must be correctly adjusted so that the specific gravity of the batteries is kept at a point not lower than 1.240. Should the gravity vary or register below this point it indicates improper adjustment at the generator.

A careful check, repair or adjustment of all of the intricate apparatus that comprises the air-conditioning units is essential during the monthly inspection period and while only the major items of maintenance have been listed in this article it is imperative that the complete system be thoroughly inspected and adjusted to prevent mechanical failures before the end of the next inspection period.

Inspection Equipment and Tools

While well trained men are essential for the proper maintenance of air-conditioning equipment it is also necessary that they be provided with the proper tools and equipment to take care of their work and while many special tools are used by mechanics it is necessary to maintain the following equipment at each inspection and repair point:

Complete set of "S" wrenches
Complete set of socket wrenches with ratchet attachment
Stillson wrenches, size 6 in., 8 in., 12 in., 18 in., and 24 in.
Electric soldering iron (32v.)
Assorted files
Gasoline blow torch for use in pipe sweating
Flexible charging hose for application of refrigerant
Supply of litharge and glycerine for use at connections
High-pressure gage with necessary connections
Low-pressure gage with necessary connections
Vacuum pump for evacuating refrigerant lines
Pliers
Tinners shears
Wire brushes for cleaning coils
75-ft. section of ½-in. air hose
Hack saws
Assorted chisels
Assorted screw drivers
High pressure lubricating gun
Breast drill and assorted set of high speed drills

A repair shop should be provided for use of the mechanics engaged in the maintenance of air-conditioning equipment and a drill press, small lathe and a grinder are the minimum tools that should constitute its equipment.

The maintenance force should be under the direction of a well trained supervisor who has a thorough knowledge of the air-conditioning equipment in order to give the mechanics accurate information and to assure that the units are given the attention they should receive.

EDUCATED RED CAPS.—Passengers turning over their luggage to the colored ushers at the Illinois Central station at Chicago probably do not realize the high degree of education prevalent among these red-caps. Not only do the ranks of these men contain many students at present, but the list of colored professional men now practising, who obtained funds for their education in this red cap corps, is surprising. It includes six lawyers, eight physicians, five dentists and two teachers. The corps is also the proud possessor of a club and a splendid building to house it, the club devoting itself to literary and other cultural activities as well as social affairs.

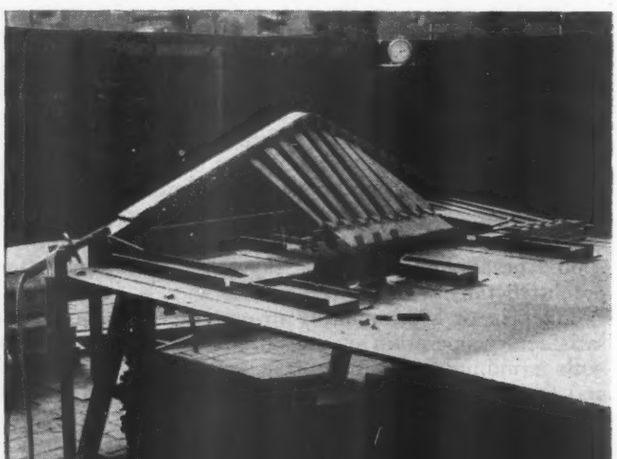
In the Back Shop and Enginehouse

All-Welded Locomotive Pilots

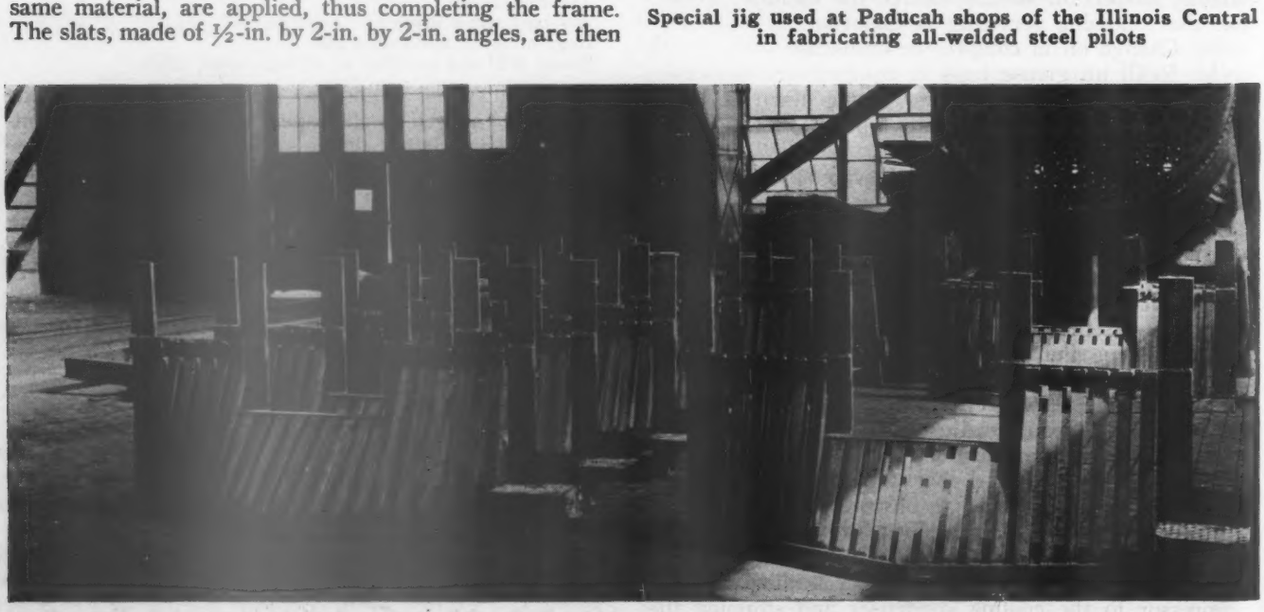
AN improved design of all-welded steel locomotive pilot has been developed for use on the Illinois Central, providing substantially stronger construction than the more familiar tubular steel type. The new pilot, made entirely of new material, is constructed on store order, usually in lots of 36 pilots at a time, the fabrication work being done at Paducah (Ky.) shops. Material used for each pilot consists of four pieces of flat stock, 1 in. by 4½ in. by 42 in.; two pieces of flat stock, ¾ in. by 3 in. by 28 in.; two pieces of angle section, ½ in. by 3 in. by 3 in. by 90 in.; 48 ft. of angle section, ¼ in. by 2 in. by 2 in.; 1 piece of T-section, ½ in. by 4 in. by 4 in. by 16 in.; 2 pieces of T-section, ⅜ in. by 3 in. by 3 in. by 10½ in.; and 9 lb. of 5/16-in. welding wire.

In building an order of these pilots, the first operation is to cut the bar stock, angles and T-sections into the proper length and shape on power shears, using templets which are available for each piece. All shearing, punching and forming operations are done cold. After all the material is cut to length and formed, it is placed in a sectional rack made for that purpose and located near the welding jig. The construction of the welding jig, which is mounted on a heavy steel table plate supported at the proper height for convenient work, is shown in the illustration. The four vertical pilot posts are placed in the jig which holds them in the exact position desired. The top cross members are then placed on these posts and the bottom cross member, which is a ½-in. by 3-in. by 3-in. angle, and the nose piece, made of the same material, are applied, thus completing the frame. The slats, made of ½-in. by 2-in. by 2-in. angles, are then properly spaced in the jig by means of the hinged positioning plates and nose piece templet and welded on one side. The pilot is removed from the jig and is then ready for a small amount of welding inside which completes the work except for the application of the steps and painting.

The welding time averages about 4 hr. per pilot but, with a newly-constructed semi-automatic welding head, it is expected to cut this time to 2 hr. 45 min. One of the illustrations shows a number of completed pilots on the boiler-shop floor ready for delivery to the stores department.



Special jig used at Paducah shops of the Illinois Central in fabricating all-welded steel pilots



Group of all-welded steel pilots completed and ready for delivery to the stores department

Applying Tires To Driving Wheels

THE method of applying locomotive driving-wheel tires, used on the Atchison, Topeka & Santa Fe, may prove of interest to shop and enginehouse men on other roads. By this method, new tires are purchased in the rough with standard treads and flanges and with sufficient inside stock to finish ⅜ in. smaller than the nominal outside diameter of the wheel center. New driving-wheel tires are applied in complete sets. New tires for trailer wheels, engine-truck wheels and tender-truck wheels are applied in pairs.

When tires are drawn from stock for application, they are mated as nearly as possible as regards outside diameter, and, where the carbon content is indicated on the tires, this is not allowed to vary more than .05 per cent in tires of the same pair. Driving-wheel tires are selected so as to secure the least possible variation in carbon content among tires of the same set. The carbon content is indicated on tires by a number prefixed by the letter "C," for example, "C 66" signifies a carbon content of .66 per cent.

When new tires are to be applied, wheel centers are carefully calipered and, if out of round or out of center more than 1/16 in., they are turned true in the wheel lathe while mounted on the axle.

Wheel centers are tested for roundness by calipering at different points, as indicated by the dash lines at *A*. Wheel centers are tested to see if they are out of center, as shown at *B*. New tires are bored to suit individual wheel centers. The inside of the tire is finished smaller than the outside diameter of the wheel center by 1/64 in. per foot of diameter.

All new tires applied to the driving and trailer wheels have retaining lips as shown at *C*. These lips must not be less than ¼ in. wide and are formed when the tires are bored. When the wheel-center rim width is too great to permit proper spacing of tires having lips of this width, the rims are turned off on the outside, as required.

If, after new tires had been applied, any variation in diameter of the tread exists between the tires of the driving wheels mounted on the same axles or coupled together by the side rods into the same set, or if the flange or the tread of any of the tires is out of round, out of center, or out of true laterally, all of the tires in the set have their treads turned true and to the same diameter. The turning is to be done with the tires on the wheel centers and wheels mounted on the axles.

The second-hand tires are fitted to individual wheel centers without shims, whenever possible, but shims are used, however, when they are necessary to provide for the proper shrinkage allowance in applying such tires.

New tires in the rough are kept in stock at designated points. When possible, new tires are applied to the wheels at these points. When ordering tires for application at other points, the exact diameter of each wheel center after it has been trued up and outside diameter of the tire when mounted are given and the shops boring and turning the tires make the usual shrinkage allowance on both bore and tread.

The Maintenance of Diesel Engine Cylinders

By H. H. Moor†

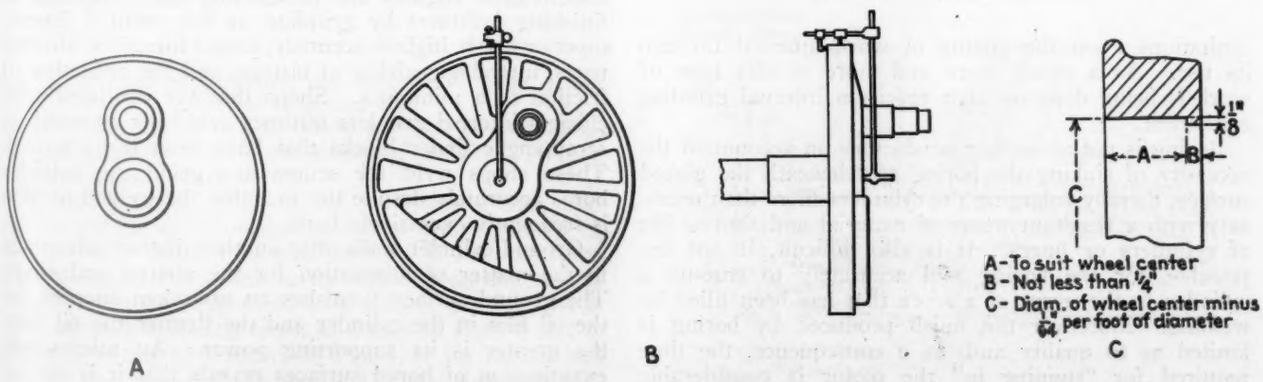
THE advent of the Diesel engine into the railroad field for powering the new types of streamlined trains and other types of present day motive power brings to the railroad shop a problem that is somewhat new to the mechanical personnel. Fortunately, however, the maintenance of these engines is not new to many other industries and a wealth of sound information regarding satisfactory methods for overhaul are available.

It is quite probable that the future will bring about a steady and perhaps rapid use of Diesel and gasoline powered locomotives. These articles, which deal with well-known methods of boring, dry grinding and wet grinding, are designed to aid the railroads in selecting the most approved methods and to be relieved of going through an expensive period of learning for themselves what other industries have discovered through a long series of "try everything."

The fact that many shops are not properly equipped for this work contributes more to the high cost of maintenance and upkeep of the oil engine than any other factor. Hence a study of methods and machines employed in this work is deemed worth while.

Cylinder finishing is an important phase of this maintenance work, inasmuch as the quality of cylinder wall finish seriously affects power, wear, fuel consumption and amount of lubricating oil used. There are several causes for faulty wear in the cylinder walls. Blocks will warp slightly in service and this warpage throws the cyinder bore slightly out of line. The movement of the pistons and rings eventually wears the cylinder bores at the top causing a tapered cylinder. When the cylinder bores are out of line, the cylinders will naturally wear

† The Micro Corporation, Bettendorf, Iowa.



Method used on the Santa Fe of testing wheel centers for roundness and concentricity

out-of-round in addition to the taper. These conditions are not unusual. They are, in fact, very common and are the most frequent causes of power loss and excessive fuel and oil consumption.

After a motor has run several thousand miles and begins to lose power, regrinding the valves, installing new plugs and cleaning out carbon are partial remedies only. By carefully measuring the worn cylinders, it will usually be found that the walls have worn away with the result that there is more clearance than there should be. It is a grave mistake to install new rings or pistons without refinishing the cylinder walls. New rings and pistons will not fit a cylinder that is out of true, and in spite of the money spent in overhauling, only a part of the original power is restored. The saving in fuel and oil will more than repay the cost of the cylinder finishing expense, aside from the many important advantages derived from a more powerful and efficient motor.

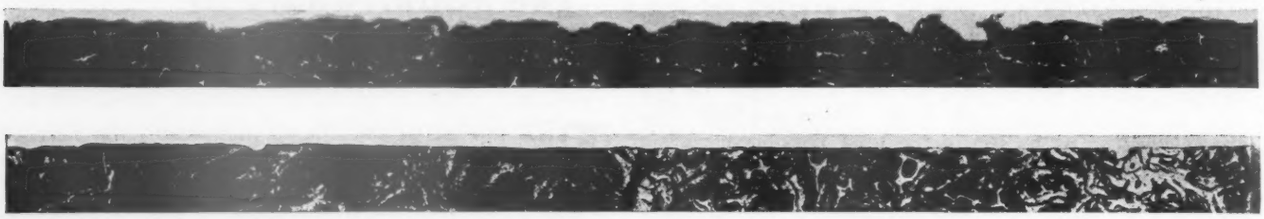


Fig. 1—(top) shows how a bored cylinder wall looks when magnified 40 times, while Fig. 2 (bottom) shows a ground wall surface

Why Boring is Unsatisfactory

In years gone by, boring was most commonly used for cylinder finishing, but the inherent nature of the boring operation imposes difficulties which place serious limitations upon the quality of work attained through its use. As a result more and more of this type of work is being done on high precision internal grinding equipment.

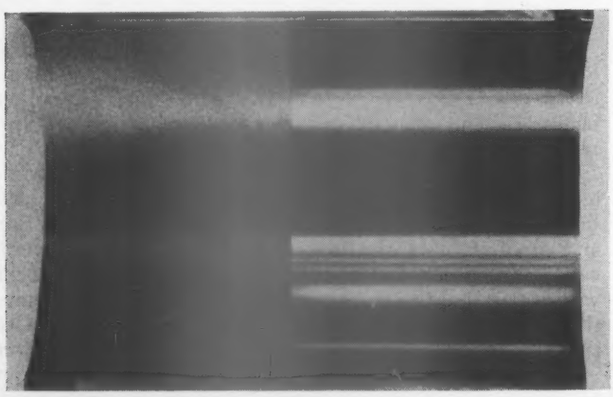


Fig. 3—A cylinder, half of which has been dry-ground and the other half bored

Boring is not altogether satisfactory on account of the necessity of sinking the boring tool beneath the glazed surface, thereby enlarging the cylinders more than necessary with a resultant waste of material and shorter life of cylinders or liners. It is also difficult, if not impossible, for the boring tool accurately to true-up a cylinder in the event of a score that has been filled by welding. Moreover the finish produced by boring is limited as to quality and, as a consequence, the time required for "running in" the motor is considerably lengthened.

The force exerted by a boring tool is considerable, and the strain necessary for holding a cylinder liner while being bored is such as to produce a certain amount of distortion. The resulting irregularities will deform the shape of the piston due to the untrue surface against which it must operate. In grinding, however, the liner is so lightly clamped and held that no measurable distortion results. This assures that it will be accurately bedded.

In considering the microphotographs in Figs. 1 and 2, attention is invited to the fact that these are unretouched microscopic views taken by Brush Laboratories, Cleveland, Ohio. The comparison between bored and ground surfaces is significant. The roughness of the bored surface results in excessive wear and an early decrease in efficiency; probability of piston seizure is apparent. The smoothness of the ground surface in Fig. 2 permits the rings to seat much more rapidly and to maintain higher mechanical efficiency over a longer period of service.

This smoothness permits a closer fit of the pistons and rings, and wear from internal friction is materially reduced. The desired glazed surface is produced mostly by the grinding wheel and not by frictional wear as in the bored cylinder. Experience shows that the bored cylinder is not only less efficient to start with but loses its economy much sooner than the ground cylinder.

Fig. 3 shows a cylinder that has been half dry-ground and half bored. It will be noted that the pores of the metal in the bored surface are open and full of pits caused by the tearing action of the boring tool. In grinding, this condition is not prevalent as the grinding wheel tends to burnish or close the pores of the metal. The bored cylinder presents a minutely corrugated surface which must be worn smooth by the friction of pistons and rings, while the ground cylinder presents virtually full surface area after the first few service miles.

Diesel and gas-engine cylinder liners are usually very thin. Therefore, internal grinding offers an outstanding advantage in exerting a minimum of outward pressure in finishing the bores.

Manufacturers of Diesel, and other types of high-compression engines are recognizing the advantage of finishing cylinders by grinding as this method insures superior finish, highest accuracy, longer life of the affected parts, interchangeability of pistons, and the reduction of friction to a minimum. Shops that are equipped with efficient internal grinders ofttimes avoid the necessity of scrapping cylinder blocks that have been badly scored. These shops weld the scores and grind the cylinder bores accurately despite the fact that the welded portion is frequently excessively hard.

Ground cylinder walls offer another distinct advantage in the matter of lubrication for the pistons and rings. The ground surface furnishes an unbroken support for the oil film in the cylinder and the thinner the oil film, the greater is its supporting power. An microscopic examination of bored surfaces reveals that it is full of hills and valleys, which cause a pronounced variation

in the thickness of the oil film, and makes it impossible to maintain the minimum thickness required for maximum supporting power. At the same time the sharp high spots of the bored surface are likely to produce a local concentration of pressure too great for the oil film to withstand. The result is the familiar type of destruction known as scoring, which not infrequently leads to piston seizure.

The period of running-in new pistons and cylinders is characterized by an inherent tendency to cause excessive heat which destroys the lubricant. The probability of piston seizure and consequent scoring of liners is eliminated in the ground cylinders and the engine goes into service ready to take the full load immediately without the slightest danger of such impairment taking place. The period of service between grindings is greater than the period of service between borings, largely due to the superior qualities of the ground cylinder from the lubricating standpoint.

The second article on this subject, which will appear in next month's issue of *Railway Mechanical Engineer*, will cover actual laboratory tests of motors, the cylinders of which have been finished by various grinding methods.

Maintaining Water-Column Valves and Fittings

PERHAPS the most important single operation in connection with the care of locomotive is the maintenance of water-glass and water-column valves and fittings in suitable condition to give reliable readings of boiler-water levels. Among other roads, the Atchison, Topeka & Santa Fe has given particular study to this

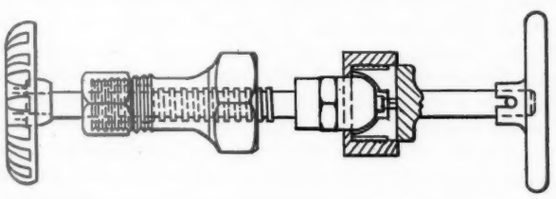


Fig. 1—Method of renewing the bearing on the drain-valve stem

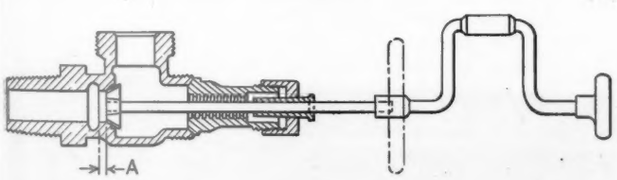


Fig. 2—Method of reseating the drain-valve body, using a special reseating tool

subject and developed a standard practice for maintaining and cleaning these parts which, if followed, is sure to produce the desired results.

By this practice, drain valves on water glasses and water columns are thoroughly cleaned and reground at each monthly inspection, and oftener if necessary, to prevent leaks. If the seat in the valve or on the stem is cut and cannot be reground to a steam-tight joint, it is faced off with reseating tools, as shown in Figs. 1 and 2.

The reseating tool, shown in Fig. 1, is for use on ball surfaces on the end of the stem. The one shown in Fig. 2 is for use on the seat in the valve body. Just enough metal is removed from the ball on the stem or the seat in the valve to clean it up. When the seat in the valve has been trued up so that the dimension *A*, Fig. 2, is less than $\frac{1}{16}$ in., a new body is applied.

Fig. 3 shows the application of a modified bottom fitting which is standard on the Santa Fe. All bottom ends of water columns have the passage through the bottom vertical sleeve and the horizontal passage in the bottom

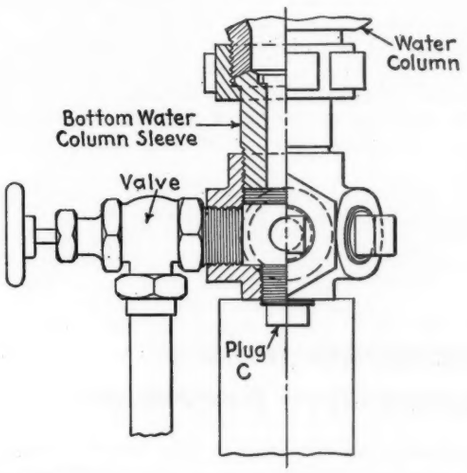


Fig. 3—Application of a modified bottom fitting to a water column

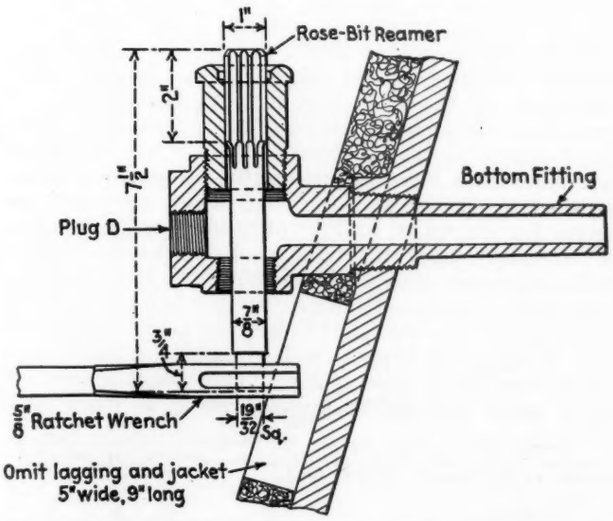


Fig. 4—Cleaning the vertical sleeve with a rose-bit reamer and small ratchet wrench

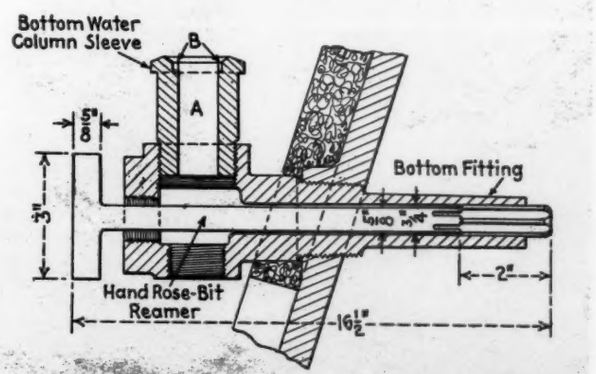


Fig. 5—Cleaning the bottom fitting with a hand-operated rose-bit reamer

fitting cleaned out each time the boiler is washed. These passages are cleaned by running a rose-bit through them, as shown in Figs. 4 and 5. Originally, the sleeve on the bottom of the water column was provided with lugs, which are now removed and slots *B* chipped as shown in Fig. 5.

In order to permit running a rose-bit through the passage in the bottom vertical sleeve, as shown in Fig. 4, the jacket and lagging below the bottom fitting is left off for a width of 5 in. and a length of 9 in. At the time of cleaning out the bottom sleeve and fitting, plug *C*, Fig. 3, and plug *D*, Fig. 4, are removed to permit inserting the rose-bit reamer. When any flexible staybolt bolt caps interfere with the operation of the rose-bit reamer, these bolts are removed and bolts with flush sleeve caps applied.

Comments from a Locomotive Foreman*

A LOCOMOTIVE foreman's first worry and a very important consideration is the enginehouse and its working facilities. An enginehouse should be of sufficient capacity to house all the locomotives required to be at the house at one time. Much waste is caused by having to keep locomotives outside, under steam, particularly during cold weather, and it follows that good outside facilities should be provided, insuring quick movement of the locomotive into the enginehouse. A coal chute of sufficient size to store, if possible, a three-days' supply of coal is desirable It should be located not more than three engine-lengths away from ashpit, be easy to operate and one from which coal will run freely for the quick loading of tenders without waste.

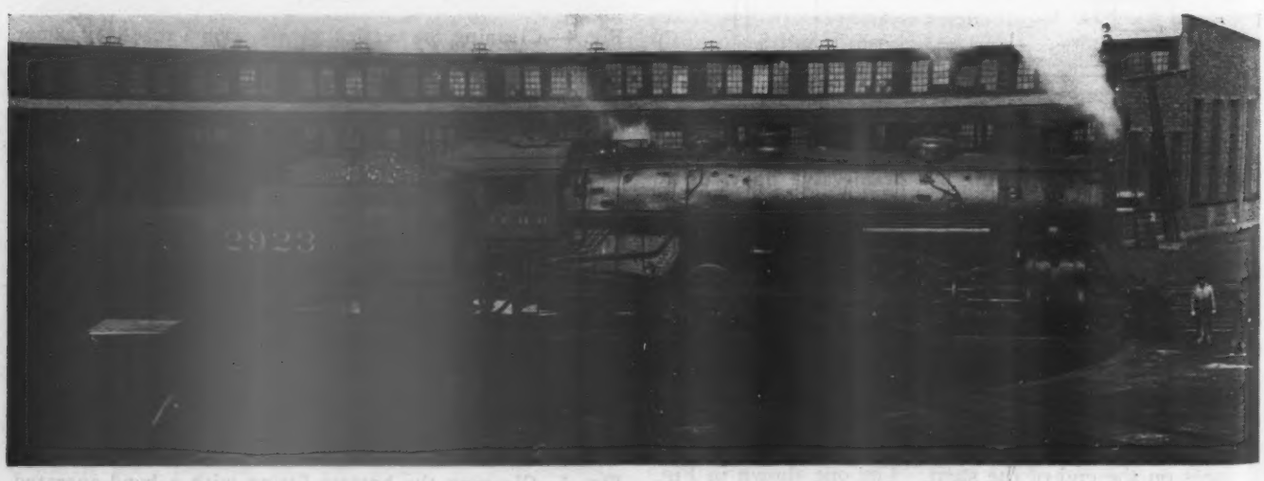
An ashpit, over which locomotives can be handled with a minimum of delay, is desirable. We have in operation on the Canadian Pacific a conveyor belt ashpit which is the best I have seen anywhere. The ashes are dumped into a depressed hopper, and conveyed by buckets on an endless belt to waiting cars. This ashpit is operated by a motor and can be installed under as many shop tracks as desired. With proper handling the ashes can be put into cars practically free from water, thus avoiding the heavy expense we formerly had unloading frozen ashes during winter months. On the ashpit car track, an air winch is provided to move ash cars under the elevators. This does away with the necessity of switching cars by motive power.

Well-Equipped Machine Shop a Necessary Adjunct

A necessary adjunct to the enginehouse is a well-planned, well-equipped machine shop, built on the outside circumference of the enginehouse with three or more of the enginehouse shop tracks extending into it and with drop pits capable of taking care of any wheel job required. This brings all heavy repairs close to the various machines, and is a time saver. A well-equipped machine shop should have one large engine lathe, a Bullard vertical turret lathe, a large drill press for heavy drilling and boring, a small drill press for lighter drill work and a shaper of sufficient stroke to take care of necessary shaping jobs arising. An electric welding machine wired to all parts of the enginehouse shortens the time for certain repairs. The vertical turret lathe is not usually included in machine shop equipment, but the shop that I am in charge of is equipped with a vertical lathe, and I find that it has speeded up the possible output of floating main-rod connections and side-rod bushings about three hundred per cent.

An efficient boiler plant is something which relieves the locomotive foreman of a lot of worry, and also pays for itself many times over in savings in fuel and wages. I have at the Glen what I think is an exceptional boiler plant. It consists of a battery of five Babcock and Wilcox water tube boilers. These boilers are stoker fed and slack coal is used as fuel. The singular thing about this plant is that during the last five or six years the consumption of fuel has been gradually decreasing while the load has been increasing. I have some figures here that will give you an idea of what I mean. In the year 1926 we burned a total of 10,401 tons. That has been gradually decreasing until last year we burned 7,600 tons. As it was a very severe winter last winter and we had quite an increase in the load, those figures are rather phenomenal. These boilers are equipped with Elesco superheaters and a funny thing occurred the first time we turned steam into the different lines. Apparently when they first turned the steam on, several fires broke out in different parts of the yards, as these lines pass through the car shop and several other buildings at the

* Excerpts from a paper by W. H. Stevenson, locomotive foreman, Canadian Pacific, Glen Yards, Montreal, Can., presented at the October meeting of the Canadian Railway Club.



A turntable with three-point support is a great time-saver in terminal handling of locomotives

Glen, and there was a hurry up phone call from the then superintendent at the terminals to the superintendent of motive power, telling him he would have to do something and do it quick with this superheated steam business at Glen, or it would burn down all the buildings. The S.M.P. said, "If you clean up the pipe lines and all the birds' nests in it and the accumulated dust you will not have any fires."

Locomotive Inspection—Prevention of Hot Bearings

No work performed in a railway shop is as exacting as locomotive inspection, and every foreman should impress this fact on the men under him at every opportunity. In my opinion, every one connected with the locomotive department, regardless in what capacity, should be, in a sense, a locomotive inspector, and should not hesitate to draw to the foreman's attention any defect which might cause trouble. This especially applies to men riding locomotives in road service, for they are in a position to watch the locomotive in operation, an advantage that is not accorded the foreman who is maintaining it. Many peculiarities of locomotive performance can only be detected while it is in road service.

Hot bearings on a locomotive are the cause of train delays, a great source of worry for the locomotive foreman, also increasing the cost of maintenance, and we have found that if every one will do as he should do, ninety-nine per cent of hot bearings can be eliminated. In avoiding hot boxes, next to the roller bearing, I think the floating hub liner has done more on engine trucks and idler boxes than any other single item. The only trouble we have had with these floating hub liners has been when some one has applied a liner that did not have sufficient freedom on the axle to turn easily. These liners also provide an easy method of keeping lateral wear to the required amount, and avoid excessive wear on boxes and wheel hubs.

Alemite lubrication on motion pins and grease lubrication on wrist pins has saved a large number of motion bushings and little end brasses. Periodical inspection of brasses and wedges and the renewal of packing in our tender boxes has practically done away with hots from this source. The adoption of the floating bushes in our main and intermediate rods has greatly decreased the number of hots we used to have with the sectional brass. I have found that floating main rod bushings, if applied too long so that they come in contact with the intermediate bushings, preventing them from turning, are one cause of hot main rod bushings.

In lubricating locomotive guide bars, and after experimenting with force-feed oil lubrication, also Alemite greasing, it was found that the syphon oil cup gives a more satisfactory performance, provided they are maintained in good condition.

Sectional Driving Box Gives Good Results

The Grisco sectional driving box has practically eliminated the trouble we previously had in maintaining main boxes. The Grisco box, unfortunately, for quite a while received some hard knocks. In fact, it was almost at the point where the railways were about to throw it out altogether, but through experimenting from one method to another, we eventually arrived at a way in which this box could be maintained and kept in good condition. For instance, I might cite the case of locomotive 2814, in heavy, fast service. We reconditioned a set of sectional side brasses on No. 2814 after it had done about 45,000 miles, and the locomotive went back into service. Last week I had to look at them again and, on the right side of the locomotive, the side brasses were practically in the same condition, as good a fit as they were when they were first reconditioned. That is, they had only a few thousandths of an inch wear, and the left side of the locomotive had a total of $\frac{1}{64}$th of an inch play at the hub.

Expansion plates and slides poorly maintained are very hard on the locomotive and the cause of heavy repair costs. Plates should be kept perfectly tight at the anchoring points and slide bearings well lubricated to permit free expansion of the boiler. In closing, I cannot stress too strongly the importance of accurately squared main valves. Possibly no other single phase of the locomotive plays as important a part when considered from a good, economical performance viewpoint as does the well-squared locomotive.

* * *

RAILROAD NICKNAMES.—The number of railroad nicknames seems endless, and, judging from the flood of correspondence received in this regard, it is an extremely popular subject.

In this connection, E. E. Parker of Akron, Ohio, wonders why the S. A. L. escaped the nickname of the "Sally" when the M-K-T is so universally known as the "Katy."

Among the list of other nicknames sent in are the following:

Elizabethtown, Lexington & Big Sandy—Eat Little & Be Satisfied.

Bellaire, Zanesville & Cincinnati—Bent, Zigzag & Crooked

Terre Haute & Peoria—Take Hold & Push

Cincinnati, New Orleans & Texas Pacific—Connections No Object, Tickets Please

Georgia, Florida & Alabama—Gophers, Frogs & Alligators

Mississippi River & Bonne Terre—Miserable Road & Bad Track

International Great Northern—Irishman Going North

Lake Shore & Michigan Southern—Large Stations & Miserable Salaries

Chicago Great Western—Corn Growers' Weekly

Minneapolis & St. Louis—Missing & Still Lost

Morris & Essex—Methodist & Episcopal

The latter road acquired its nickname from the fact that no trains were operated over it on Sunday.

Further explanation furnished by the Editor upon request

Among the Clubs and Associations

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—Draft Gears will be the subject presented by J. M. Hall, mechanical superintendent, Cardwell-Westinghouse Company, before the January 17 meeting of the Southern and Southwestern Railway Club to be held at 10 a.m. at the Ansley Hotel, Atlanta, Ga.

NEW ENGLAND RAILROAD CLUB.—W. J. Patterson, director, Bureau of Safety, I.C.C., will address the New England Railroad Club on the subject of Co-ordination between Departments of the Individual Railroad following a dinner of the New England Railroad Club to be held on January 8 at the Copley-Plaza Hotel, Boston, Mass.

MECHANICAL CONVENTIONS.—The Mechanical Division of the Association of American Railroads will hold a two-day full membership business meeting, without exhibits, in Chicago, the latter part of next June. A special committee is now considering the desirability of holding conventions of the minor mechanical department associations in May, but no decision has as yet been announced.

RAILWAY BUSINESS ASSOCIATION.—The annual dinner of the Railway Business Association was held at the Hotel Commodore, New York City, Thursday evening, December 6, about 1,400 members and guests being in attendance. J. J. Pelley, president of the Association of American Railroads, was the guest of honor. He responded to the introduction of the president of the Association, H. A. Wheeler, with an expression of appreciation for the co-operation of the Railway Business Association, and with a short statement of the objectives of the Association of American Railroads. At a business meeting of the Railway Business Association, held on the same afternoon, officers and members of the board were all re-elected.

NEW YORK RAILROAD CLUB.—The annual dinner of the New York Railroad Club was held at the Hotel Commodore on Thursday evening, December 13, about 2,400 members and guests being in attendance. Charles E. Smith, vice-president in charge of purchases and stores of the New York, New Haven & Hartford, and recently elected president of the New York Railroad Club, acted as toastmaster and master of ceremonies. Except for brief statements on the part of the president, who insisted that railroad prospects are brighter and better than at any time since the depression started in 1929, the program was confined largely to entertainment features. George LeBoutillier, vice-president of the Pennsylvania Railroad, who had just completed four years as president of the club, was presented with a suitable token of esteem.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Clarence E. Davies, executive secretary of the American Society of Mechanical Engineers, has been elected secretary of that organization to succeed the late Calvin W. Rice. Mr. Davies was born in Utica, N. Y., and was graduated from the Rensselaer Polytechnic Institute in 1910. He was employed in the production department of the Smith Premier Works, Syracuse, N. Y., of the Remington Typewriter Company, and during the war was first lieutenant and, later, captain in the Ordnance Department, U. S. Army. He now holds the rank of lieutenant colonel in the Ordnance Reserve Corps. He first became associated with the American Society of Mechanical Engineers in 1920, as associate editor, and after various promotions was made executive secretary in 1931.

Directory

The following list gives names of Secretaries, dates of next regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, c/o Westinghouse Air Brake Company, Thirty-fourth floor, Empire State Bldg., New York. 1935 meeting tentatively planned for May 2 to 4, inclusive, Hotel Sherman, Chicago.

ALLIED RAILWAY SUPPLY ASSOCIATION.—F. W. Venton, Crane Company, Chicago.

ASSOCIATION OF AMERICAN RAILROADS.—J. R. Downes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

DIVISION I.—OPERATING.—SAFETY SECTION.—J. C. Caviston, 30 Vesey street, New York.

DIVISION V.—MECHANICAL.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

COMMITTEE ON RESEARCH.—H. A. Johnson, chairman (Director of Research, Association of American Railroads), Chicago.

DIVISION VI.—PURCHASE AND STORES.—W. J. Farrell, 30 Vesey street, New York.

DIVISION VIII.—MOTOR TRANSPORT.—CAR SERVICE DIVISION.—C. A. Buch, Transportation Building, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago. 1935 meeting tentatively planned for May 6, 7 and 8, Hotel Sherman, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 W. Thirty-ninth street, New York.

RAILROAD DIVISION.—Marion B. Richardson, Room 332, 30 Church street, New York.

MACHINE SHOP PRACTICE DIVISION.—G. F. Nordenholt, 330 W. Forty-second st., New York.

MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.

OIL AND GAS POWER DIVISION.—M. J. Reed, 2 W. Forty-fifth st., New York.

FUELS DIVISION.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Jos. A. Andreucetti, C. & N. W., 1519 Daily News Building, 400 W. Madison St., Chicago, Ill.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan street, Chicago. 1935 meeting tentatively planned for May 2 to 4, inclusive, Hotel Sherman, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month except June, July and August, La Salle Hotel, Chicago, Ill.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meeting, second Thursday each month except June, July and August at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four building, Indianapolis, Ind. Regular meetings first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich. 1935 meeting tentatively planned for May 6, 7 and 8, Hotel Sherman, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—T. D. Smith, 1660 Old Colony building, Chicago. 1935 meeting tentatively planned for May 6, 7 and 8, Hotel Sherman, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha street, Winona, Minn. 1935 meeting tentatively planned for May 2 to 4, inclusive, Hotel Sherman, Chicago.

MASTER BOILERMAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. 1935 meeting tentatively planned for May 6, 7 and 8, Hotel Sherman, Chicago.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meeting first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium building, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CLUB OF GREENVILLE.—Ralph D. Stewart, 21 Sherrard avenue, Greenville, Pa. Regular meeting third Thursday in month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver building, Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August, Ft. Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—N. A. Walford, district supervisor car service, Canadian National, Toronto, Ont. Meetings first Friday of each month except June, July, August and September.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio. Annual meeting tentatively planned for May 2 to 4, 1935, Hotel Sherman, Chicago.

WESTERN RAILWAY CLUB.—C. L. Emerson, 822 Straus building, Chicago. Regular meetings third Monday in each month except June, July, August and September.

NEWS

Lubrication of Railroad Car Journals—A Correction

In the fifth line under the subhead "Importance of Viscosity" of the article bearing the above title on page 407 of the November *Railway Mechanical Engineer*, the figure 10 c.c. is given. This should have been 60 c.c.

B. & M. Shops Reopened

The Boston & Maine reopened on January 2 its locomotive shops at Billerica, Mass., which had been closed since July. This, together with similar action at Concord passenger-car shops, and Keene motor-car shops, will give work to 650 mechanics.

Chicago-Twin Cities Streamlined Train Service in February

The two streamlined articulated trains ordered by the Chicago, Burlington & Quincy from the Edward G. Budd Manufacturing Company for operation between Chicago and the Twin Cities will be placed in service about the middle of February. Present plans call for a schedule of 6½ hr. Chicago to St. Paul and 7 hr. to Minneapolis.

Milwaukee Locomotive Makes Record Mileage

The record of 18,390 miles in a single month made by a 4-6-4 locomotive of the Chicago, Milwaukee, St. Paul & Pacific, during November, 1933, was bettered during the month of October, 1934, by Baldwin-built locomotive No. 6415 of the same type which is operated by the Milwaukee in fast passenger service between Minneapolis, Minn., and Harlowton, Mont., when it ran up a total of 19,200 miles.

Grecian Roads Negotiating Loan for Improvements

The Piraeus-Athens-Peloponnesus is negotiating a loan of about $1,000,000 from the Grecian government, the funds to be spent for roadbed improvements and the purchase of rolling stock, according to recent reports received by the U. S. Department of Commerce. The equipment to be purchased includes 6 locomotives of the 2-8-0 type with separate tenders, or, instead of these locomotives, motor rail cars of 300 hp.; 7 motor rail cars of 120 to 150 hp., 108 steel box cars, 10 first class passenger cars, 8 second class passenger cars, and 5 to 10 baggage cars.

C. N. R. Raises Wages

Announcement was recently made in Ottawa by A. R. Mosher, president of the Canadian Brotherhood of Railway Employees, that an agreement had been reached between the brotherhood, representing clerks, freight handlers, shop roundhouse and station employees on the Canadian National and the C.N.R. management, providing that, in the case of all employees whose basic wage rates had been reduced by 15 per cent, this deduction will be at the rate of 12 per cent effective January 1, and 10 per cent as from May 1, 1935, with proportionate modifications for those whose rates were subject to a 10 per cent deduction.

The management has announced a similar restoration in the wage rates of unorganized employees.

German Railroads Increase Speed

Increases in the general speed of passenger trains of the German National Railroads Company are included in the 1935 schedule of the system. Eight new streamlined flyers will be the most important improvement in the speed of the system's train service. These new trains will be fashioned, in principle, after the "Flying Hamburger," which has been on scheduled service between Berlin and Hamburg since May, 1933. The runs on which these new "Schnelltriebwagen" will be operated are Berlin-Cologne, Hamburg-Cologne, Berlin-Munich, Nuremberg-Stuttgart, Berlin-Leipzig, Berlin-Dresden, Berlin-Breslau-Beuthen and Berlin-Koenigsberg. On most other runs, trains will be speeded up to a considerable extent.

Long Island Exhibits Remodeled Passenger Coach

An experimental steel motor-equipped passenger car, which is to be tested by runs over all parts of the Long Island system, was placed on exhibition December 27 at the road's Jamaica station. The car is streamlined and of a color resembling aluminum instead of the road's standard Tuscan red. The special car, fitted out in Long Island shops, will be tried out first on the Port Washington branch. Long Island officers are especially interested in testing the qualities of the aluminum coating used on the car, known under the trade name of "alumaneal," which is said to possess both sun-deflecting and insulating properties, making the car cooler in summer and warmer in winter. The protective coating is described as neither a paint nor varnish but rather a thin sheathing of aluminum metal.

C. & N. W. First High-Speed Steam Train

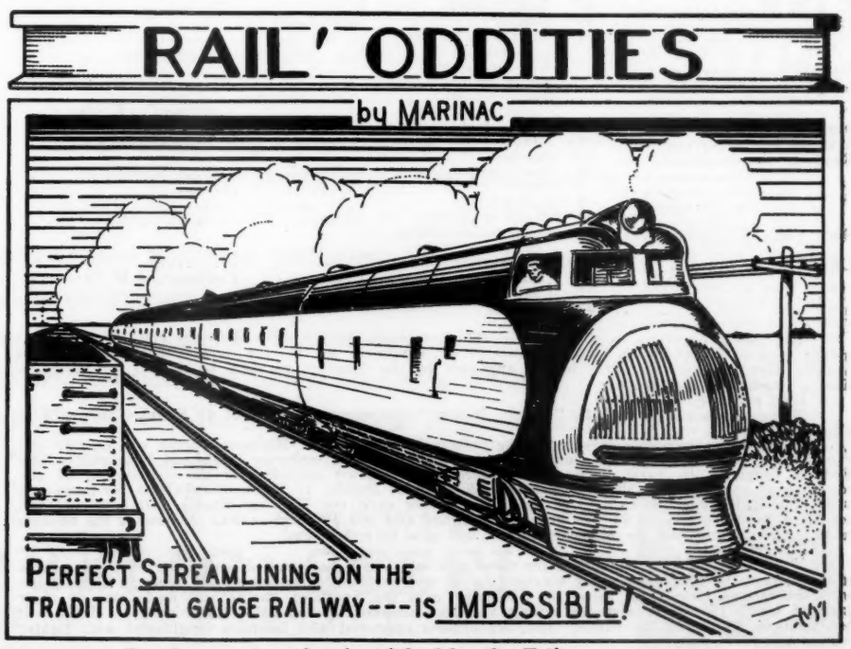
The first high-speed standard steam-driven passenger train designed to compete with modern streamlined light-weight Diesel-electric trains was placed in service by the Chicago & North Western on January 2 between Chicago and the Twin Cities, 481½ miles, on a seven-hour schedule, the maximum average speed attained between stations being about 75 m.p.h.

The train, known as "The Four Hundred," is drawn by an E-2 class (4-6-2 type) locomotive, which has been converted to use oil instead of coal and on which the driving-wheel diameter has been increased 4 in. to 79 in.

Both northbound and southbound trains consist of five modernized and completely air-conditioned steel cars, including one baggage-coach, one standard coach and one lounge coach, one dining car and one parlor-observation car. The interiors of the cars have been redecorated in bright colors and new seats have been added.

Locomotive Statistics for 1933

Preliminary statistics on wage earner employment in the construction of steam and internal-combustion locomotives in the United States during 1933, as compiled from data collected in the Biennial Census of Manufacturers taken in 1934, and released by Director William L. Austin,



Further explanation furnished by the Editor upon request

Bureau of the Census Department of Commerce, are given in the accompanying tables, together with comparative figures for earlier years. The figures for 1933 are subject to revision.

TABLE 1.—SUMMARY FOR THE INDUSTRY: 1933, 1931, AND 1929

	1933	1931	1929
Number of establishments	13	16	16
Wage earners (average for the year)	2,374	5,443	11,045
Wages	$1,862,529	$5,589,610	$17,994,078
Cost of materials, fuel, and purchased electric energy	$4,266,218	$14,870,591	$52,808,092
Products, total value	$6,927,300	$22,118,636	$83,858,258
Locomotives (other than electric) and parts	$2,827,931	$13,763,130	$70,961,472
Other products (not normally belonging to the industry)	$2,164,809	$6,349,851	$8,804,961
Receipts for contract and repair work	$1,934,560	$2,005,655	$4,091,825
Value added by manufacture	$2,661,082	$7,248,045	$31,050,166

TABLE 2.—WAGE EARNERS, BY QUARTERS: 1933 AND 1931

(The figure given for the final month of each quarter is the total number of wage earners on the pay rolls for the week including the fifteenth day of the month, or for some other representative week in the month.)

Census year	March	June	September	December
1933.....	2,084	2,083	2,641	2,827
1931.....	6,603	5,691	4,962	3,875

P. W. A. Loans to Railroads

APPROXIMATELY 150,000,000 man-hours of employment, extending into every state, were created last year by PWA railroad loans, Public Works Administrator Harold L. Ickes announced in reviewing nation-wide results of a year's campaign to create jobs for unemployed by making self-liquidating loans to railroad companies. Loans to 30 railroad companies amounted to $193,276,500 of the PWA fund.

More than 52,000,000 of these man-hours were worked by men and women called back to regular employment by railroad companies and equipment manufacturers. The balance was worked by men and women called back to work by production of more than $100,000,000 worth of materials and supplies purchased by the railroad companies and equipment makers. This indirect employment was created in the heavy industries, where unemployment was most acute.

New Equipment

CAR ORDERS

Road	No. of cars	Type of car	Builder
B. & L. E.....	100[1]	69.5-ton hopper	Pressed Steel Car Co.
C. & O.	10	50-ton lt. weight hopper	American Car & Fdry. Co.
C. B. & Q.	1[2]	Pass. car	Edw. G. Budd Mfg. Co.
Lehigh Valley	250[3]	70-ton gondolas	Bethlehem Steel Co.
Nat'l Rys. Mexico	200	Box	Gen. Amer. Trans. Co.
	200	Gondolas	Gen. Amer. Trans. Co.
	800	Std. gage box	P. C. & Mfg. Corp.
	200	Narrow-gage box	P. C. & Mfg. Corp.
	200	Std. gage gondola	P. C. & Mfg. Corp.

CAR INQUIRIES

Key System, Ltd.....	10 to 25[4]	2-car articu. units	.....
Liquid Carbonic Corp.	5	40-ton steel-sheathed box	.....
Sorocabana Ry. (Brazil)...	350	Box	.....
	80	Cattle	.....

LOCOMOTIVE INQUIRIES

Road	No. of locos.	Type of locomotive	Builder
Seaboard Air Line	3	Loco. tenders (16,000 gal. cap.)	.....

MISCELLANEOUS ORDERS

Road	Type of equipment	For use on	Order placed with
B. & M.	Anti-friciton roller bearings	21 new pass. cars	Fafnir,Bearings Inc.
C., M., St. P. & P.	Roller-bearing units	2 streamlined locos.[5]	American Steel Fdries.
G. M. & N.	Bearings and boxes	2 streamlined trains[6]	Timken Roller Bearings Co.
N. Y., N. H. & H.	Anti-friction roller bearings	10 new pass. cars	Fafnir,Bearings Inc.
Western Md.	Loco. valve pilots	4 freight locos.	Valve Pilot Corp.

[1] To be of light weight Cor-Ten steel construction.

[2] A fourth car to be added to the Zephyr. The road has asked for the quickest possible delivery due to the fact that the Zephyr has increased traffic on this line to the point where the original equipment will not carry the daily traffic and it has been necessary to put on a steam train to follow the Zephyr and take care of the overflow.

[3] These cars are to be of mill type. 125 will be equipped with Miner heavy friction draft gears and 125 with Duryea cushion underframes. The purchase will be financed by a P. W. A. loan.

[4] These three-truck, four-motor, light-weight steel articulated units are for service on the new San Francisco, Cal.-Oakland bridge.

[5] All outboard positions under the locomotives and tenders, namely, rear trailer truck and tender trucks, will be equipped with American Steel Foundries units. These high-speed steam locomotives are being built by the American Locomotive Company.

[6] These two high-speed 4-car passenger trains are under construction at the Berwick, Pa., plant of the American Car & Foundry Co.

Progress in Air-Conditioning Programs

Road	No. of cars	Type of car	Type of system	Builder
A. T. & S. F.....	167[1]	Pullman and chair cars and coaches	.....	Safety Car & Htg.
C. & N. W.....	67[2]	Tourist, sleep.	Mech. and ice	.....
.....	37	Coaches		
.....	31	Dining, parlor and observa.		
Grt. Nor.	..	Day coaches and tourist sleep.[3]	.....	.....
Ill. Central	..	4 sets thermal gravity systems (see footnote 4)	.....	American Car & Fdry. Co.
Mo. Pac.	..		.....	
Pullman Co.	878	Cars	.....	B. F. Sturtevant Co.
Reading Co.[5]	11[6]	Coaches	.....	.....
.....	5	Pass. and bagg.	.....	.....
.....	2	Cafe	.....	.....
.....	1	Parlor-cafe	.....	.....
.....	1	Parlor coach	.....	.....
Sou. Pac.	260[6]	Sleep, parlor, dining, chair and coaches	.....	.....
Union Pac.	17	Diners	.....	Pullman C. & M. Corp.
.....	13	Observation		
.....	21	Chair		
.....	40	Coaches		

[1] The Santa Fe plans to air-condition 273 cars, including 78 railroad-owned and 195 Pullman-owned cars by next spring. The installation of equipment in the 167 cars is being done at its Topeka, Kan., shops. The 1935 budget approved by the directors includes $2,250,000 for air-conditioning passenger equipment.

[2] 1935 program.

[3] These cars are a part of the "Empire Builder" equipment. A total of 43 Pullman cars will be air-conditioned.

[4] All passenger-carrying cars in all the principal trains on the Missouri Pacific will contain air-conditioning equipment by next summer, as a result of court authority issued on November 17 by Federal Judge C. B. Faris. The order issued by the court provides for the installation of air-conditioning equipment in 89 cars, including 68 Missouri Pacific, 17 International-Great Northern and 4 St. Louis, Brownsville & Mexico cars. With these cars, the Missouri Pacific will have 193 air-conditioned cars, of which 91 will be railroad-owned and 102 Pullman-owned. Eleven of the 68 cars to be air-conditioned on the Missouri Pacific will also be redecorated.

[5] Contemplated.

[6] The air-conditioning equipment for these cars which will be installed within the next six months to supplement the 100 cars already air-conditioned, will cost approximately $2,000,000. In conjunction with the air-conditioning of these 260 passenger cars the Southern Pacific will modernize 41 chair cars, of which 15 will be virtually rebuilt and 26 completely overhauled. Reclining type chairs will be installed, floors will be rubber tiled, washrooms improved and interiors brightened with lighter colored paints.

Reviewing the results of the PWA railroad improvement and construction program, Administrator Ickes pointed out that:

Loans of $59,390,250 were made to 18 railroad companies to purchase new engines, freight and passenger cars and high-speed streamlined trains manufactured in outside shops.

These equipment purchase loans resulted in the placing of orders for 14,675 freight cars, 264 passenger train cars, 70 steam engines, 20 Diesel engines, 33 electric locomotives and 4 high-speed trains. Orders were placed with 26 manufacturers and latest reports show that 8,292 new freight cars, 73 passenger cars and 8 locomotives have been completed.

Of the $133,886,250 loaned to railroad companies to put their own forces back to work, $65,580,484 was loaned to create employment for shop men. Fourteen companies received loans and have called shop men back to repair, rebuild and modernize 35,694 freight cars, 1,694 locomotives and 1,946 passenger cars, and on building 88 new locomotives, 10,736 freight cars and 75 passenger cars. This repair work also is rapidly nearing completion, with 28,439 freight cars, 1,416 passenger cars and 1,522 locomotives finished.

Materials purchased for shop men up to November 15 totalled $37,532,000.

(*Turn to next left-hand page*)

PARTS *made to fit* MUST BE HELD SECURELY

It's a waste of time, money and materials to make parts fit unless that fit is securely held. » » To hold related parts securely in proper relationship is the reason for the special properties of Agathon Alloy Steels for engine bolts. » » Agathon Alloy Engine Bolt Steel possesses unusual toughness and has high tensile strength. » » These qualities enable Agathon Alloy engine bolts to withstand vibration and unusual stresses without permitting the slack that causes premature shopping. » » Agathon Engine Bolt Steel is but one of Republic's Special Service Steels. » » Whatever your steel problem, consult Republic. » »

REPUBLIC PRODUCTS

Republic Double Strength Steel for Transportation Industry : Toncan Iron Boiler Tubes, Pipe, Plates, Culverts, Rivets, Tender Plates and Firebox Sheets : Sheets and Strip for special railroad purposes : Agathon Alloy Steels for Locomotive Parts : Agathon Engine Bolt Steel : Agathon Iron for pins and bushings : Agathon Staybolt Iron : Climax Steel Staybolts : Upson Bolts and Nuts : Track Material, Maney Guard Rail Assemblies : Enduro Stainless Steel for dining car equipment, refrigeration cars and fire box sheets : Agathon Nickel Forging Steel.

CENTRAL ALLOY DIVISION, MASSILLON, OHIO

REPUBLIC STEEL
CORPORATION
GENERAL OFFICES YOUNGSTOWN, OHIO

Reg. U. S. Pat. Off.

AGATHON STEELS

Supply Trade Notes

GEORGE T. WILLARD is now associated with the P. & M. Company, Chicago.

DAVID M. CURRY and FRED J. WALLS have joined the development and research staff of the International Nickel Company, Inc., with headquarters at New York.

DAVID K. E. BRUCE has been elected a director of the American Locomotive Company, New York, to fill the vacancy caused by the resignation of Seward Prosser.

ROBERT TREAT PAINE, II, for 40 years a director of the General Electric Company, has resigned on account of ill health. Mr. Paine was elected to the board in 1894, two years after the formation of the company.

WALTER COLPITTS, of the engineering firm of Coverdale & Colpits, New York City, has been elected a director of the Edward G. Budd Manufacturing Company, Philadelphia, Pa., and a member of the executive committee.

THE KELVINATOR CORPORATION, Detroit, Mich., has opened a factory sales branch at 830 Rush street, Chicago, with G. E. Rogo as manager and A. E. Cadwell, formerly with Kelvinator's Boston branch, as head of the commercial division, and John S. Garceau has been appointed advertising and sales promotion manager of the air-conditioning division of the Kelvinator Corporation at Detroit, Mich.

EUGENE G. GRACE, president of the Bethlehem Steel Corporation, has been elected president of the American Iron & Steel Institute, New York, succeeding to the position which has been vacant since the resignation in September, 1933, of Robert P. Lamont. T. M. Girdler, chairman and president of the Republic Steel Corporation, has been elected a vice-president of the Institute.

THE REPUBLIC STEEL CORPORATION, Youngstown, Ohio, has appointed the Buhl Sons Company, Detroit, Mich.; the F. W. Heitmann Company, Houston, Texas, and the Woodward Company, Albany, N. Y., warehouse distributors of Enduro stainless steel; and the Steel Products Company, McKees Rocks, Pa., has been appointed warehouse distributors of Republic's Toncan iron sheets in the Pittsburgh area. The corporation is spending $500,000 for a new building and new finishing equipment in its Youngstown, Ohio, electric weld tube mills. The new building will house equipment and provide additional storage space for finished pipe.

THE BROWN INSTRUMENT COMPANY, Philadelphia, Pa., has been consolidated with the Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., and will continue as a separate company with its existing organization but as a subsidiary of Minneapolis-Honeywell. Richard P. Brown will continue as president of The Brown Instrument Company and will become an officer and director of the Minneapolis-Honeywell Company.

BONNELL W. CLARK, general manager of the Westinghouse Electric Supply Company, has been appointed vice-president and general manager, with headquarters at New York; H. N. Gansman, general sales manager, has been appointed a vice-president at New York; and R. J. Holtermann, district manager for the company's entire operations west of the Rocky Mountains, with headquarters at San Francisco, Cal., has been appointed a vice-president.

THE WORTHINGTON COMPANY, INC., Harrison, N. J., has established a Pacific Coast regional headquarters at Los Angeles, Cal., which will center jurisdiction of the corporation's business in the western territory now included in the Worthington district offices at Seattle, Wash., San Francisco, Cal., Los Angeles and El Paso, Tex. C. E. Wilson, vice-president, is in charge of the Pacific Coast division and has moved his office from New York to 510 West Sixth street, Los Angeles.

C. T. RESSLER, manager of railroad and marine sales of the Reading Iron Company, has been appointed specification engineer, sales division, with headquarters at Philadelphia, Pa.; R. I. Fretz, district sales representative at Columbus, Ohio, has been appointed manager of eastern railroad and marine sales, with headquarters at Philadelphia; C. W. Guthrie, salesman in the New York district, has been appointed district sales representative for the Columbus territory; Bryant Myers has joined the Pacific Coast sales force, with headquarters at San Francisco, Cal.; E. S. Morrow has joined the oil territory sales force with headquarters at Tulsa, Okla., and F. B. Olcott has been appointed special representative for the purpose of handling government business at Washington, D. C.

THOMAS T. WATSON, who joined the metallurgical department of Lukens Steel Company, Coatesville, Pa., in August, 1931, has been appointed development and service metallurgist. He will be engaged principally in service and sales work in connection with Lukens Nickel-Clad Steel. Mr. Watson was born in Scotland 35 years ago and was graduated in 1923 from the Royal Technical College, Glasgow, with the degree of associate of the R.T.C. Until 1925 he was assistant metallurgist at David Colville & Sons, iron and steel manufacturers of Scotland. He then became metallurgist at the Clyde Alloy Steel Company, serving there for two years. From 1927 to 1930 he was assistant metallurgist at Dorman Long & Company, iron and steel manufacturers of England. He came to the United States in 1930 and engaged as a consulting metallurgist in New York until he joined the Lukens organization in 1931.

HARRY M. GREEN has been appointed manager of mechanical goods sales, Pacific Coast division, United States Rubber Products, Inc., New York. This division is comprised of the Los Angeles, Cal., San Francisco, Portland, Ore., Seattle, Wash., and Salt Lake City, Utah, branches. Mr. Green will co-ordinate his activities with those of J. B. Brady, general manager of the Pacific Coast division, with headquarters at San Francisco, Cal., and in addition, will continue as manager of mechanical goods sales in the San Francisco branch.

G. G. COOLIDGE, assistant to the president of the Harbison-Walker Refractories Company, Pittsburgh, Pa., has been elected a vice-president and a director of that company. Mr. Coolidge who has served for 28 continuous years with that company was graduated from Yale University in 1904. Shortly after his graduation he became connected with the Delaware, Lackawanna & Western and later left the railroad to go with the Westinghouse Air Brake Company, Wilmerding, Pa. In 1906 he entered the service of the Harbison-Walker Refractories Company and has been actively identified with this interest ever since. He first served as a member of the Pittsburgh district sales office; five years later, in 1911, he was appointed district sales manager at Pittsburgh. In 1921 he was appointed assistant general sales manager and in 1929, assistant to the president.

G. G. Coolidge

THE DELAWARE TOOL STEEL CORPORATION, Wilmington, Del., announces that Richard D. Fletcher has been appointed district manager in its railway department. Mr. Fletcher will also act as factory representative for the Armstrong-Blum Manufacturing Company, Chicago, and Skilsaw, Inc.; the Arthur Colton Company, Detroit, Mich., and the Arrow Tool & Reamer Company; the Goodall Rubber Company, Philadelphia, Pa.; and the Marlo Company, New York. Mr. Fletcher, who is well known in the railway mechanical field and in the supply trade, was machine shop foreman at the Belt Railway of Chicago

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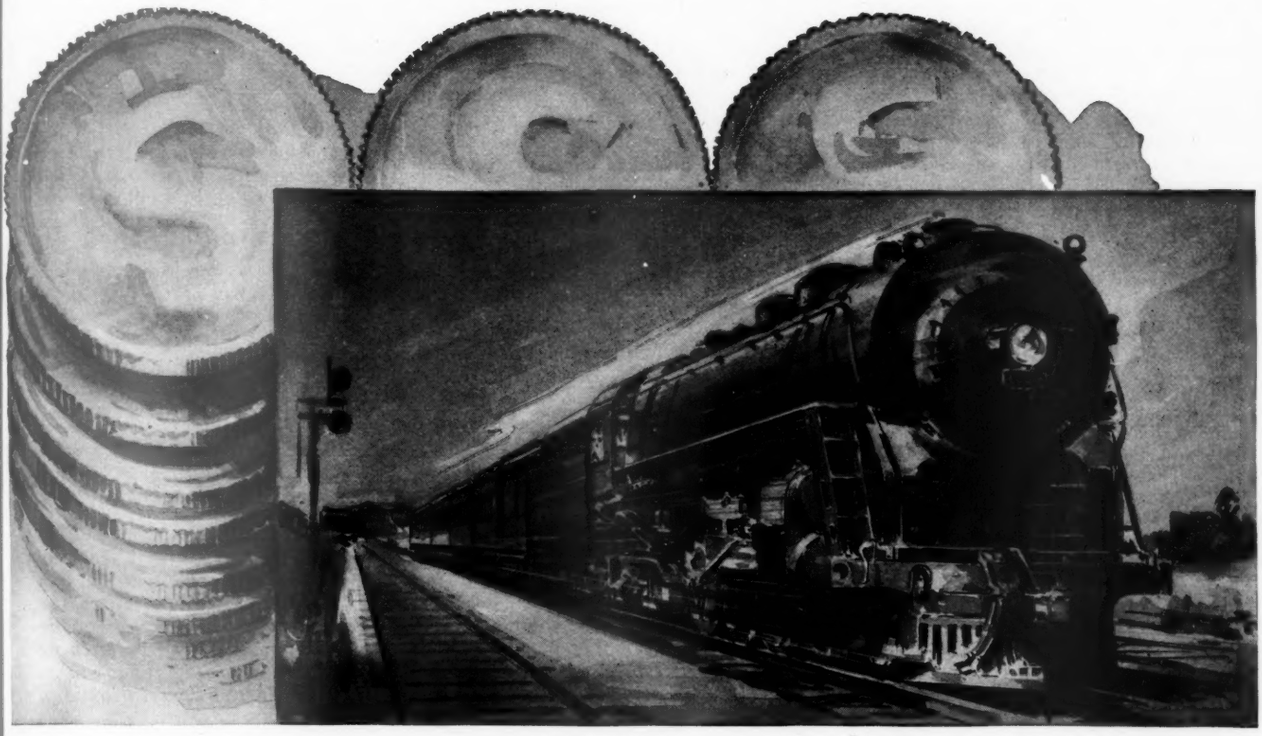

IT COSTS MONEY TO PROPEL EXCESS WEIGHT DAY IN AND DAY OUT

There are fundamentally two ways in which power can be produced to haul a train.

One, with all power produced in the main cylinders.

The other, part of the power produced in the main cylinders and the remainder produced as needed in auxiliary cylinders.

With the Booster to produce power as needed—locomotive weight for a given set of conditions is kept at a minimum.

This results in lower costs of operation and lower costs for locomotive maintenance as a whole.

The close tolerances essential to efficient Booster operation call for genuine repair parts made by Franklin.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

shops, and subsequently secretary-treasurer of the American Railway Tool Foremen's Association, as well as being a member of the International Railway General Foremen's Association and associate of the American Society of Mechanical Engineers. For a period of about sixteen years, Mr. Fletcher represented the Crucible Steel Company of America, railway department.

Obituary

HERBERT J. BECK, director, assistant treasurer and factory sales manager of Aluminum Industries, Inc., Cincinnati, Ohio, died suddenly at the company's office on December 14. Mr. Beck had never fully recovered from injuries sustained during the World War.

Personal Mention

General

E. BECKER, master mechanic of the Green Bay & Western, has been appointed to the newly-created position of superintendent of motive power and equipment, with headquarters as before at Green Bay, Wis.

Master Mechanics and Road Foreman

JAMES W. NORTH, master mechanic of the Port Huron & Detroit, with headquarters at Port Huron, Mich., has retired.

THEODORE OLSON, traveling engineer of the Chicago Great Western, has been appointed general road foreman of engines, with headquarters at Oelwein, Iowa.

HOWELL T. COVER, who has been appointed master mechanic of the Northern division of the Pennsylvania, with headquarters at Buffalo, N. Y., was born on August 25, 1897, at Altoona, Pa. He is a graduate of Pennsylvania State College (1919). His service with the Pennsylvania began on August 6, 1915. He was a draftsman in the office of the electrical engineer from June 12, 1917, until January 16, 1920, when he became a special apprentice. From October 18, 1922, until May 1, 1923, he was a motive power inspector, office of electrical engineer. On the latter date he became assistant foreman and foreman at the Long Island City (N. Y.) power plant, and on July 16, 1924, became foreman substations and transmission, Philadelphia electrification. He was appointed gang foreman locomotive repairs at the East Altoona enginehouse on June 16, 1929; assistant foreman locomotive repairs at the Camden (N. J.) enginehouse on September 20, 1930; assistant master mechanic at Wilmington, Del., on January 1, 1931, and master mechanic at Buffalo on November 1, 1934.

WALTER BUDWELL, who has been appointed master mechanic of the Norfolk & Western at Crewe, Va., was born on August 7, 1889, at Roanoke, Va. He attended the public schools at Roanoke and on June 21, 1905, became a laborer at the Roanoke shops of the Norfolk & Western. He became a machinist apprentice on August 17, 1906; machinist, on December 15, 1910; enginehouse foreman at Crewe on May 20, 1912, and enginehouse foreman at West Roanoke on November 1, 1912. During three months of 1913 Mr. Budwell inspected locomotives built for the N. & W. by the American Locomotive Works at Richmond, Va., after which, on October 1, 1913, he was promoted to the position of foreman at East Radford, Va. On December 1, 1915, he was transferred to the position of foreman at Shenandoah, Va., and on September 1, 1917, was furloughed for military service during the World War, serving overseas with the French Army in railroad transportation service from September, 1917, to June, 1919. During this time he organized and commanded the Fourth Battalion, 35th Engineers, and for his outstanding service was given a citation by the French Legion of Honor. Upon his return to the Norfolk & Western he became general foreman at Kenova, W. Va., and on January 1, 1922, was transferred to the position of general foreman at Bluefield, W. Va. He was appointed master mechanic of the Shenandoah division on January 1, 1923, and on May 16, 1932, because of the consolidation of the position of master mechanic of the Shenandoah division with that of the Radford division, he was sent to Shaffer's Crossing, Va., as general foreman, which position he held until his appointment as master mechanic at Crewe.

Walter Budwell

Shop and Enginehouse

E. V. FOX, gang leader of the Norfolk & Western at Portsmouth, Ohio, has been promoted to the position of assistant enginehouse foreman at Shaffer's Crossing, Va.

Purchasing and Stores

S. E. KEILLOR, assistant general storekeeper of the Canadian National at Winnipeg, Man., has been appointed general storekeeper of the Western region, with headquarters at Winnipeg, succeeding D. Robertson, who has retired because of ill health.

S. SNEDDON, district storekeeper of the Canadian National at Toronto, Ont., has been appointed assistant general storekeeper, with headquarters at Winnipeg, Man., to succeed S. E. Keillor.

Obituary

W. O. MOODY, mechanical engineer of the Illinois Central at Chicago, died suddenly on December 25.

J. H. BEGGS, purchasing agent of the Chicago & Eastern Illinois, with headquarters at Chicago, died on December 18 of pneumonia.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

REFRIGERATING MACHINE OIL.—The Frick Company, Waynesboro, Pa., in Bulletin No. 140-A, describes Frick oil, a dehydrated mineral oil, for refrigerating machines.

ARC WELDERS.—The Air Reduction Sales Company, Lincoln building, New York, has issued an eight-page, illustrated booklet outlining the features and advantages of Airco-Wilson arc welders.

PAINT PRODUCTS.—"Integrity of Finishes" is the title of a booklet issued by the Bakelite Corporation, Bound Brook, N. J. These paints are applicable to marine finishes, railway coatings, anti-corrosive primers and finishing coats, etc.

FORGINGS.—The Kropp Forge Company, 5301 W. Roosevelt Road, Chicago, has issued a buletin entitled "Forging the Impossible," in which its facilities for handling a wide variety of hammered forgings, shafts, rings, die blocks, etc., are discussed.

LOW PRESSURE AIR.—Under the title "Low Pressure Air vs. Compressed Air for Rivet Heating Forges," the Mahr Manufacturing Company, Minneapolis, Minn., has issued technical bulletin No. 7 which contains extensive descriptive material, tabular data and calculations showing the economies which may be expected by use of modern low-pressure equipment.

COATED ELECTRODES.—The Air Reduction Sales Company, New York, has issued a leaflet describing shielded arc electrodes Nos. 78, 79 and 81. Airco rods Nos. 78 and 79 have a tensile strength of from 60,000 to 75,000 lb. per sq. in., an elongation of from 22 to 30 per cent, and a high resistance to corrosion. No. 78 is recommended for flat welding, while No. 79 is for vertical and overhead work. No. 81 a heavily coated electrode for flat welding only, has similar characteristics, except that its elongation runs about 5 per cent greater